DEPARTMENT OF ENERGY

10 CFR Parts 429 and 431

[EERE–2017–BT–TP–0010]

RIN 1904–AD78

Energy Conservation Program: Test Procedures for Walk-In Coolers and Walk-In Freezers

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of proposed rulemaking and announcement of public webinar.

SUMMARY: The U.S. Department of Energy (''DOE'') proposes to amend the test procedures for walk-in coolers and walk-in freezers to harmonize with updated industry standards, revise the test methods to more fully represent field energy use, and better account for the range of walk-in cooler and walk-in freezer component equipment designs. DOE also proposes to revise certain definitions applicable to walk-ins. DOE is seeking comment from interested parties on the proposal and announcing a public meeting to collect comments and data on its proposal.

DATES: DOE will accept comments, data, and information regarding this proposal no later than June 21, 2022. *See* section V, ''Public Participation,'' for details. DOE will hold a webinar on Monday, May 9, from 1:00 p.m. to 5:00 p.m. *See* section V, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov,* under docket number EERE–2017–BT–TP–0010. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments by email to *WICF2017TP0010@ee.doe.gov.* Include docket number EERE–2017–BT–TP–0010 in the subject line of the message.

No telefacsimiles (''faxes'') will be accepted. For detailed instructions on submitting comments and additional information on this process, *See* section V of this document.

Although DOE has routinely accepted public comment submissions through a variety of mechanisms, including postal mail and hand delivery/courier, the Department has found it necessary to make temporary modifications to the comment submission process in light of the ongoing coronavirus 2019 (''COVID–19 pandemic''). DOE is currently suspending receipt of public comments via postal mail and hand delivery/courier. If a commenter finds that this change poses an undue hardship, please contact Appliance Standards Program staff at (202) 586–1445 to discuss the need for alternative arrangements. Once the COVID–19 pandemic health emergency is resolved, DOE anticipates resuming all of its regular options for public comment submission, including postal mail and hand delivery/courier.

Docket: The docket, which includes **Federal Register** notices, public meeting attendee lists and transcripts (if a public meeting is held), comments, and other supporting documents/materials, is available for review at *www.regulations.gov.* All documents in the docket are listed in the *www.regulations.gov* index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

The docket web page can be found at *www.regulations.gov/docket/EERE-2017-BT-TP-0010.* The docket web page contains instructions on how to access all documents, including public comments, in the docket. *See* section V for information on how to submit comments through *www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT:

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For further information on how to submit a comment, review other public comments and the docket, or participate in a public meeting (if one is held), contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

SUPPLEMENTARY INFORMATION: DOE proposes to maintain previously approved incorporations by reference and to incorporate by reference the following industry standards into part 431:

ANSI/AHRI Standard 420–2008, ''Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration,'' copyright 2008.

AHRI Standard 1250 (I–P)–2009, ''Standard for Performance Rating of Walk-in Coolers and Freezers,'' (including Errata sheet dated December 2015), copyright 2009, except Table 15 and Table 16.

AHRI Standard 1250–2020, ''Standard for Performane Rating of Walk-in Coolers and Freezers,'' copyright 2020.

Copies of AHRI 420–2008, AHRI 1250–2009, and AHRI 1250–2020 can be obtained from the Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, or by going to *www.ahrinet.org.*

ANSI/ASHRAE Standard 16–2016, ''Method of Testing for Rating Room Air Conditioners, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps for Cooling and Heating Capacity,'' approved October 31, 2016.

ANSI/ASHRAE Standard 23.1–2010, ''Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant,'' ANSI approved January 28, 2010.

ANSI/ASHRAE Standard 37–2009, ''Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment,'' approved June 24, 2009.

Copies of ANSI/ASHRAE 16, ASHRAE 23.1–2010, and ANSI/ASHRAE 37 can be obtained from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, 180 Technology Parkway, Peachtree Corners, GA 30092, or by going to: *www.ashrae.org.*

ASTM C518–17, ''Standard Test Method for Steady state Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus,'' ASTM approved May 1, 2017.

ASTM C1199–14, ''Standard Test Method for Measuring the Steady state Thermal Transmittance of Fenestration Systems Using Hot Box Methods,'' ASTM approved February 1, 2014.

Copies of ASTM C518–17 and ASTM C1199–14 can be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428–2959, or by going to *www.astm.org.*

NFRC 102–2020 [E0A0], ''Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.''

Copies of NFRC 102–2020 can be obtained from the National Fenestration Rating Council, 6305 Ivy Lane, Ste. 140, Greenbelt, MD 20770, or by going to *www.nfrc.org/.*

See section IV.M of this document for a further discussion of these standards.

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I. Authority and Background

Walk-in coolers and freezers (collectively, ''WICFs'' or ''walk-ins'') are included in the list of ''covered equipment'' for which DOE is authorized to establish and amend energy conservation standards and test procedures. (42 U.S.C. 6311(1)(G)) DOE's energy conservation standards and test procedures for WICFs are currently prescribed at subpart R of part 431 of title 10 of the Code of Federal Regulations (''CFR''). The following sections discuss DOE's authority to establish test procedures for WICFs and relevant background information regarding DOE's consideration of test procedures for this equipment.

A. Authority

The Energy Policy and Conservation Act, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C.

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020).

6291–6317) Title III, Part C [2] of EPCA, added by Public Law 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This covered equipment includes walk-in coolers and walk-in freezers, the subject of this document. (42 U.S.C. 6311(1)(G))

Under EPCA, the energy conservation program consists essentially of four parts: (1) Testing, (2) labeling, (3) Federal energy conservation standards (''ECS''), and (4) certification and enforcement procedures. Relevant provisions of EPCA include definitions (42 U.S.C. 6311), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), energy conservation standards (42 U.S.C. 6313), and the authority to require information and reports from manufacturers (42 U.S.C. 6316).

The Federal testing requirements consist of test procedures that manufacturers of covered equipment must use as the basis for: (1) Certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(a); 42 U.S.C. 6295(s)), and (2) making representations about the efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. (42 U.S.C. 6316(a); 42 U.S.C. 6295(s))

Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and 42 U.S.C. 6316(b); 42 U.S.C. 6297) DOE may, however, grant waivers of Federal pre-emption for particular State laws or regulations, in accordance with the procedures and other provisions of EPCA. (42 U.S.C. 6316(a))

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results that reflect the energy efficiency, energy use or estimated annual operating cost of a given type of covered equipment during a representative average use cycle and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including walk-ins, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect the energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 6314(a)(1))

In addition, if the Secretary determines that a test procedure amendment is warranted, the Secretary must publish proposed test procedures in the **Federal Register** and afford interested persons an opportunity (of not less than 45 days' duration) to present oral and written data, views, and arguments on the proposed test procedures. (42 U.S.C. 6314(b)) If DOE determines that test procedure revisions are not appropriate, DOE must publish its determination not to amend the test procedures. (42 U.S.C. 6314(a)(1)(A)(ii)) DOE is publishing this notice of proposed rulemaking (''NOPR'') in satisfaction of the 7-year review requirement specified in EPCA.

B. Background

For measuring walk-in energy use, DOE has established separate test procedures for the principal components that make up a walk-in (*i.e.,* doors, panels, and refrigeration systems), with separate test metrics for each component. 10 CFR 431.304(b). For walk-in doors and display panels, the efficiency metric is daily energy consumption, measured in kilowatt-hours per day (''kWh/day''), which accounts for the thermal conduction through the door or display panel and the direct and indirect electricity use of any electrical components associated with the door. 10 CFR 431.304(b)(1)–(2) and 10 CFR part 431, subpart R, appendix A, ''Uniform Test Method for the Measurement of Energy Consumption of the Components of Envelopes of Walk-In Coolers and Walk-In Freezers'' (''appendix A''). The thermal transmittance through the door, which inputs into the calculation of thermal conduction, is determined using National Fenestration Rating Council (''NFRC'') 100–2010, ''Procedure for Determining Fenestration U-factors'' (''NFRC 100'').

For walk-in non-display panels and non-display doors, DOE codified in the CFR standards established in EPCA based on the R-value metric,[3] expressed in units of (h-ft^2-°F/Btu),[4] which is calculated as the thickness of the panel in inches (''in.'') divided by the K-factor.[5] *See* 10 CFR 431.304(b)(3) and 10 CFR part 431, subpart R, appendix B, titled ''Uniform Test Method for the Measurement of R-Value for Envelope Components of Walk-In Coolers and Walk-In Freezers'' (''appendix B''). (*See also,* 42 U.S.C. 6314(a)(9)(A)) The K-factor is calculated based on American Society for Testing and Materials (''ASTM'') C518, ''Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus'' (''ASTM C518''), which is incorporated by reference at 10 CFR 431.303. *Id.*

For walk-in refrigeration systems, the efficiency metric is Annual Walk-in Energy Factor (''AWEF''), which is the ratio of the total heat, not including the heat generated by the operation of refrigeration systems, removed, in Btu, from a walk-in box during one-year period of usage for refrigeration to the total energy input of refrigeration systems, in watt-hours, during the same period. AWEF is determined by conducting the test procedure set forth in American National Standards Institute (''ANSI'')/Air-Conditioning, Heating, and Refrigeration Institute (''AHRI'') Standard 1250P (I–P), ''2009 Standard for Performance Rating of Walk-In Coolers and Freezers,'' (''AHRI 1250–2009''), with certain adjustments specified in the CFR. *See* 10 CFR 431.304(b)(4) and 10 CFR part 431 subpart R, appendix C, ''Uniform Test Method for the Measurement of Net Capacity and AWEF of Walk-In Cooler and Walk-In Freezer Refrigeration Systems'' (''subpart R, appendix C''). A manufacturer may also determine AWEF using an alternative efficiency determination method (''AEDM''). 10 CFR 429.53(a)(2)(iii). An AEDM enables a manufacturer to utilize computer-based or mathematical models for purposes of determining an equipment's energy use or energy efficiency performance in lieu of testing, provided certain prerequisites have been met. 10 CFR 429.70(f).

On August 5, 2015, DOE published its intention to establish a working group

[2] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

[3] The R-value is the thermal resistance, or the capacity of an insulated material to resist heat-flow. See Section 3.3.3 of ASTM C518. *See* 42 U.S.C. 6313(f)(1)(C) for the EPCA R-value requirements for non-display panels and doors.

[4] These symbols represent the following units of measurement—h: hour; ft^2: square foot; °F: degrees Fahrenheit; Btu: British thermal unit.

[5] The K-factor represents the thermal conductivity of a material, or its ability to conduct heat, in units of Btu-in/(h-ft^2-°F). See Section 3.3.1 of ASTM C518.

under the Appliance Standards and Rulemaking Federal Advisory Committee (''ASRAC'') to negotiate energy conservation standards to replace the standards established in the final rule published on June 3, 2014 (79 FR 32050; ''June 2014 ECS final rule''). 80 FR 46521. The established working group (''ASRAC Working Group'') assembled its recommendations into a Term Sheet[6] (Docket EERE–2015–BT–STD–0016, No. 56) that was presented to, and approved by, ASRAC on December 18, 2015 (''ASRAC Term Sheet'').

The ASRAC Term Sheet provided recommendations for energy conservation standards to replace standards that had been vacated by the United States Court of Appeals for the Fifth Circuit in a controlling order issued August 10, 2015. It also included recommendations regarding definitions for a number of terms related to the WICF regulations, as well as recommendations to amend the test procedure that the ASRAC Working Group viewed as necessary to properly implement the energy conservation standards recommendations. Consequently, DOE initiated both an energy conservation standards rulemaking and a test procedure rulemaking in 2016 to implement these recommendations. The ASRAC Term Sheet also included recommendations for future amendments to the test procedures intended to make DOE's test procedure more fully representative of walk-in energy use.

On December 28, 2016, DOE published a final rule amending the WICF test procedures (''December 2016 final rule''), consistent with the ASRAC Term Sheet recommendations and including provisions to facilitate implementation of energy conservation standards for walk-in components. 81 FR 95758. Subsequently, on July 10, 2017, DOE published a final rule amending the energy conservation standards for WICF refrigeration systems (''July 2017 ECS final rule''). 82 FR 31808.

AHRI published an updated industry test standard for walk-in refrigeration systems in 2020, ''2020 Standard for Performance Rating of Walk-in Coolers and Freezers,'' (''AHRI 1250–2020''). This test procedure included updated calculations for the determination of default values for equipment with electric defrost and hot gas defrost. DOE published a final rule for hot gas defrost unit coolers on March 26, 2021 (''March 2021 final rule'') that amended the test procedure to rate hot gas defrost unit coolers using the modified default values for energy use and heat load contributions in AHRI 1250–2020. These amendments ensure that ratings for hot gas defrost unit coolers are consistent with those of electric defrost unit coolers. 86 FR 16027.

Under 10 CFR 431.401, any interested person may submit a petition for waiver from DOE's test procedure requirements. DOE will grant a waiver from the test procedure requirements if DOE determines either that the basic model for which the waiver was requested contains a design characteristic that prevents testing of the basic model according to the prescribed test procedures, or that the prescribed test procedures evaluate the basic model in a manner so unrepresentative of its true energy consumption characteristics as to provide materially inaccurate comparative data. 10 CFR 431.401(f)(2). DOE may grant the waiver subject to conditions, including adherence to alternate test procedures specified by DOE. *Id.* DOE has granted interim waivers and/or waivers to the manufacturers listed in Table I.1 from either appendix A or subpart R, appendix C.

TABLE I.1: MANUFACTURERS WHO RECEIVED A TEST PROCEDURE WAIVER/INTERIM WAIVER FROM DOE

Manufacturer	Subject	Case No.	Waiver from appendix
Jamison Door Company	PTO for Door Motors	2017–009	A
HH Technologies	PTO for Door Motors	2018–001	A
Senneca Holdings	PTO for Door Motors	2020–002	A
Hercules	PTO for Door Motors	2020–013	A
HTPG	CO_2 Unit Coolers	2020–009	C
Hussmann	CO_2 Unit Coolers	2020–010	C
Keeprite	CO_2 Unit Coolers	2020–014	C
RefPlus, Inc.	CO_2 Unit Coolers	2021–006	C
RSG	Multi-Circuit Single-Package Dedicated Systems	2022–004	C
Store It Cold	Single-Package Dedicated Systems	2018–002	C
CellarPro	Wine Cellar Refrigeration Systems	2019–009	C
Air Innovations	Wine Cellar Refrigeration Systems	2019–010	C
Vinotheque	Wine Cellar Refrigeration Systems	2019–011	C
Vinotemp	Wine Cellar Refrigeration Systems	2020–005	C
LRC Coil	Wine Cellar Refrigeration Systems	2020–024	C

On June 17, 2021, DOE published a request for information (''RFI'') to collect information and data to consider amendments to DOE's test procedures for walk-ins (''June 2021 RFI''). 86 FR 32332. DOE received comments in response to the June 2021 RFI from the interested parties listed in Table I.2.

TABLE I.2 LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE JUNE 2021 RFI

Commenter(s)	Reference in this NOPR	Commenter type
Air-Conditioning, Heating, & Refrigeration Institute	AHRI	Industry Association
Anthony International	Anthony	Manufacturer
Appliance Standards Awareness Project	ASAP	Efficiency Organization

[6] Appliance Standards and Rulemaking Federal Advisory Committee Refrigeration Systems Walk-in Coolers and Freezers Term Sheet, available at *https://www.regulations.gov/document/EERE-2015-BT-STD-0016-0056.*

TABLE I.2 LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE JUNE 2021 RFI—Continued

Commenter(s)	Reference in this NOPR	Commenter type
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities.	CA IOUs	Utility Association
Daikin US Corporation	Daikin	Manufacturer
Hussmann Corporation	Hussmann	Manufacturer
Imperial Brown, Inc	Imperial Brown	Manufacturer
Keeprite Refrigeration, Inc.	Keeprite	Manufacturer
Lennox International	Lennox	Manufacturer
National Refrigeration & Air Conditioning Canada Corp.	National Refrigeration	Manufacturer
Northwest Energy Efficiency Alliance	NEEA	Efficiency Organization
National Fenestration Rating Council	NFRC	Industry Association

In response to the June 2021 RFI, DOE also received comments specific to energy conservation standards (''ECS''), which it will address in a future walk-in ECS rulemaking notice.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[7]

II. Synopsis of the Notice of Proposed Rulemaking

In this NOPR, DOE is proposing to expand the scope of its walk-in coolers and freezers test procedure to include carbon dioxide (''CO_2'') unit coolers, multi-circuit single-packaged dedicated systems, and ducted fan coil units. DOE has also tentatively determined that liquid-cooled refrigeration systems are within the scope of DOE coverage authority for walk-ins but is not proposing to add an applicable test procedure at this time.

In this NOPR, DOE is proposing to alter the definitions of walk-in cooler and walk-in freezer, door, door surface area, and single-packaged dedicated systems. DOE is also proposing new definitions for door leaf, hinged vertical door, non-display door, roll-up door, sliding door, high-temperature refrigeration systems, ducted fan coil units, multi-circuit single-packaged dedicated systems, attached split systems, detachable single-packaged dedicated systems, CO_2 unit coolers, and hot gas defrost.

In this NOPR, DOE is proposing to make the following revisions to appendix A: (1) Reference NFRC 102–2020 as the applicable test procedure to determine door ''U-factor'' in place of NFRC 100 (DOE proposes to adopt AEDM provisions for doors in 10 CFR 429.53 to allow calculation of door energy use representations); (2) provide further detail on and distinguish the area to be used for determining compliance with standards and the area used to calculate a thermal load from U-factor; (3) establish a percent time off (''PTO'') specific to door motors; and (4) reorganize appendix A so that it is easier to follow.

Additionally, DOE is proposing to modify appendix B to improve test representativeness and repeatability. Specifically, DOE is proposing to make the following revisions to appendix B: (1) Reference the updated industry standard ASTM C518–17; (2) include more detailed provisions for determining measuring insulation thickness and test specimen thickness; (3) provide additional guidance on determining parallelism and flatness of a test specimen; and (4) reorganize appendix B as a step-by-step procedure so it is easier to follow.

DOE is also proposing to include walk-in doors and walk-in panels in the list of covered equipment in the same sampling plan for enforcement testing that is used for walk-in refrigeration systems. *See* 10 CFR 429.110(e)(2).

DOE is proposing two sets of changes for the refrigeration system test procedure. One set of changes would be grouped into proposed revisions to subpart R, appendix C, and the other set of changes is being proposed through the establishment of a new appendix C1 to subpart R of part 431 (''appendix C1''). DOE has tentatively determined that the changes to subpart R, appendix C, would not affect AWEF ratings and therefore would not require any retesting or recertification. These proposed changes, if adopted, would be required starting 180 days after the test procedure final rule is published. DOE has tentatively determined, however, that the proposed appendix C1 would affect the measurement of energy use; therefore, DOE is proposing to establish a new metric, AWEF2, in appendix C1 which would require retesting and recertification. The requirements proposed in appendix C1, if adopted, would take place on the compliance date of amended energy conservation standards that DOE may ultimately decide to adopt as part of a separate rulemaking assessing the technological feasibility and economic justification for such standards.

DOE is proposing to make the following revisions to subpart R, appendix C:

(1) Specify refrigeration test room conditions;

(2) provide for a temperature probe exception for small diameter refrigerant lines;

(3) incorporate a test setup hierarchy for installation instructions for laboratories to follow when setting up a unit for test;

(4) allow active cooling of the liquid line in order to achieve the required 3 °F subcooling at a refrigerant mass flow meter;

(5) modify instrument accuracy and test tolerances; and

(6) address current test procedure waivers for CO_2 unit coolers tested alone and high-temperature unit coolers tested alone by incorporating amendments appropriate for this equipment.

Additionally, DOE is proposing a new metric, AWEF2, associated with a new appendix C1, which would include the proposed changes to subpart R, appendix C. DOE is proposing the following provisions be included in appendix C1, which would be required to demonstrate compliance coincident with the compliance date of any amended energy conservation standards, should such standards be established:

(1) Adoption of AHRI 1250–2020;

(2) provide for testing single-packaged dedicated systems, detachable single-packaged dedicated systems, attached split systems, CO_2, variable-, two-, and multiple-capacity dedicated condensing units, indoor variable-, two- and multiple-capacity matched pairs,

[7] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop test procedures for walk-ins. (Docket No. EERE–2017–BT–TP–0010, which is maintained at *www.regulations.gov*). The references are arranged as follows: Commenter name, comment docket ID number, page of that document.

matched refrigeration systems for high-temperature applications, and multi-circuit single-packaged dedicated systems;

(3) add a single-packaged dedicated system refrigerant enthalpy test procedure; and

(4) add a new energy metric, AWEF2, to reflect the proposed changes in the test procedure that would result in a significant change to energy use values.

Table II.1 summarizes the current DOE test procedure, DOE's proposed changes to the test procedure, the attribution for each proposed change, and the location of the proposed test procedure.

TABLE II.1—SUMMARY OF CHANGES IN PROPOSED TEST PROCEDURE RELATIVE TO CURRENT TEST PROCEDURE

WICF component(s)	Current DOE test procedure	Proposed test procedure(s)	Attribution	Proposed in appendix
Doors and Display Panels.	Incorporates by reference NFRC 100–2010 for determining U-factor as part of determining energy consumption.	Incorporates by reference NFRC 102–2020 for determining U-factor and allows for AEDMs to be used for determining energy consumption.	Reduce test burden	A
Doors and Display Panels.	Uses surface area of the door or display panel external to the walk-in to convert U-factor into a conduction load.	Requires that area of the aperture or surface area used to determine the U-factor be used to convert U-factor into a conduction load.	Improve representative values.	A
Doors	Uses a percent time off value of 25 percent for door motors (as they are considered "other electricity-consuming devices").	Establishes a percent time off value of 97 percent specific to door motors.	Improve representative values and addresses inconsistent values across waivers granted.	A
Non-display Doors and Panels.	Incorporates by reference ASTM C518–04.	Incorporates by reference ASTM C518–17.	Updates to the applicable industry test procedures.	B
Non-display Doors and Panels.	Does not include detailed provisions for determining and measuring total insulation thickness and test specimen thickness.	Includes detailed provisions for determining and measuring total insulation thickness and test specimen thickness.	Ensure test repeatability.	B
Non-display Doors and Panels.	Requires that the test specimen meet a parallelism and flatness tolerance of ±0.03 inches but provides no guidance on measurement.	Provides guidance on determining parallelism and flatness of the test specimen.	Ensure test repeatability.	B
Refrigeration Systems ...	Does not include guidance on test room conditioning.	Includes guidance on test room conditioning.	Ensure test repeatability.	C
Refrigeration Systems ...	Does not include an allowance for measuring refrigerant temperatures with surface-mounted measuring instruments.	Includes an allowance for measuring refrigerant temperatures with surface-mounted measuring instruments for small diameter tubes.	Reduce test burden	C
Refrigeration Systems ...	Does not include guidance for unit charging or a setup condition hierarchy.	Includes guidance for unit charging and a setup condition hierarchy.	Ensure test repeatability.	C
Refrigeration Systems ...	Does not include provisions for testing CO_2 unit coolers.	Includes provisions for testing CO_2 unit coolers.	Improve representative values.	C
Refrigeration Systems ...	Does not include provisions for testing high-temperature unit coolers alone.	Includes provisions for testing high-temperature unit coolers alone.	Improve representative values.	C
Refrigeration Systems ...	Incorporates by reference AHRI 1250–2009, ASHRAE 23.1–2010, and AHRI 420–2008.	Incorporates by reference AHRI 1250–2020, ASHRAE 37, and ASHRAE 16.	Updates to the applicable industry test procedures.	C1
Refrigeration Systems ...	Single-packaged dedicated systems are tested using the refrigerant enthalpy method for matched pairs.	Includes multiple methods for testing single-packaged dedicated systems.	Improve representative values.	C1
Refrigeration Systems ...	Does not include provisions for testing attached split systems or detachable single-packaged dedicated systems.	Includes provisions for testing attached split systems or detachable single-packaged dedicated systems.	Improve representative values.	C1
Refrigeration Systems ...	Does not include provisions for testing multi-circuit single-packaged dedicated systems.	Includes provisions for testing multi-circuit single-packaged dedicated systems.	Improve representative values.	C1
Refrigeration Systems ...	Does not include provisions for testing ducted fan coil units.	Includes provisions for testing ducted fan coil units.	Improve representative values.	C1
Refrigeration Systems ...	Does not include provisions for testing high-temperature matched-pair and single-packaged dedicated systems.	Includes provisions for testing high-temperature matched-pair and single-packaged dedicated systems.	Improve representative values.	C1

TABLE II.1—SUMMARY OF CHANGES IN PROPOSED TEST PROCEDURE RELATIVE TO CURRENT TEST PROCEDURE—Continued

WICF component(s)	Current DOE test procedure	Proposed test procedure(s)	Attribution	Proposed in appendix
Refrigeration Systems ...	Does not include provisions for testing of variable- and multiple-capacity dedicated condensing units nor variable- and multiple-capacity outdoor matched pairs.	Includes provisions for testing of variable, two-, and multiple-capacity dedicated condensing units and variable, two-, and multiple-capacity outdoor matched pairs.	Improve representative values.	C1

DOE has tentatively determined that the proposed amendments described in section III of this NOPR would not alter the measured energy consumption of walk-in doors without motors or the R-value of walk-in non-display doors and non-display panels or require retesting or recertification solely as a result of DOE's adoption of the proposed amendments to the test procedures, if made final. Additionally, DOE has tentatively determined that the proposed amendments, if made final, would not increase the cost of testing.

Further, DOE has tentatively determined that the proposed amendments described in section III of this NOPR would alter the measured energy consumption or efficiency of walk-in doors with motors and would only require retesting or recertification because of DOE's adoption of the proposed amendments to the test procedures, if made final. Additionally, DOE has tentatively determined that the proposed amendments, if made final, would not increase the cost of testing for doors with motors.

DOE has also tentatively determined that the proposed amendments to subpart R, appendix C, described in section III.F of this NOPR would not alter the measured efficiency of walk-in refrigeration systems and would not require retesting or recertification as a result of DOE's adoption of the proposed amendments to the test procedures, if made final. Additionally, DOE has tentatively determined that the proposed amendments, if made final, would not increase the cost of testing.

Finally, DOE has tentatively determined that the proposed provisions of appendix C1 described in section III.G of this NOPR would alter the measured efficiency of walk-in refrigeration systems. However, the proposed procedure in appendix C1 would only require retesting or recertification when a future energy conservation standard would take effect. Additionally, DOE has tentatively determined that the proposed provisions in appendix C1, if made final, would increase the cost of testing. Tentative cost estimates are discussed in section III.J of this document.

Discussion of DOE's proposed actions are addressed in detail in section III of this NOPR.

III. Discussion

In the following sections, DOE proposes certain amendments to its test procedures for walk-in doors, panels, and refrigeration systems. For each proposed amendment, DOE provides relevant background information, explains why the amendment merits consideration, discusses relevant public comments, and proposes a potential approach.

Many of the refrigeration system test procedure proposals under consideration in this NOPR stem from recommendations made by the ASRAC Working Group (*see* ASRAC Term Sheet Recommendation #6, EERE–2015–BT–STD–0016, No. 56). The remainder of the refrigeration system, door, and panel test procedure amendments proposed in this NOPR are in response to issues identified by DOE and stakeholders in the time since the publication of the December 2016 final rule, including through petitions for test procedure waivers.

A. Scope and Definitions

This NOPR applies to the test procedures for ''walk-in coolers and walk-in freezers.'' DOE defines ''walk-in cooler and walk-in freezer'' as: An enclosed storage space refrigerated to temperatures (1) above 32 °F for walk-in coolers and (2) at or below 32 °F for walk-in freezers, that can be walked into, and has a total chilled storage area of less than 3,000 square feet, but excluding equipment designed and marketed exclusively for medical, scientific, or research purposes. 10 CFR 431.302. (*See also* 42 U.S.C. 6311(20))

1. Scope

The following sections discuss considerations and proposals regarding the scope of equipment covered by DOE's test procedures for walk-ins. As discussed, the DOE test procedures and standards apply to walk-in refrigeration systems, doors, and panels.

a. Liquid-Cooled Refrigeration Systems

A -liquid-cooled refrigeration system rejects heat during the condensing process to a liquid that transports the heat to a remote location. This is in contrast to an air-cooled system, which rejects heat to ambient air during the condensing process. DOE understands that liquid-cooled refrigeration systems are typically used in facilities where either cooling water or glycol is plumbed throughout the building prior to installation of the refrigeration unit, although it is possible that some such systems use potable water for condenser cooling and dispose the water in a drain after it passes through the condenser. As discussed in the June 2021 RFI, liquid-cooled dedicated condensing units for walk-ins are readily available for a wide range of capacities and refrigerants from major walk-in refrigeration system manufacturers (*see* for example, Airdyne W-series indoor units (water-cooled), and Russell (water-cooled, glycol-cooled) [8] 86 FR 32332, 32334.

DOE notes that the EPCA definition for walk-ins makes no distinction on how the condenser is cooled. (42 U.S.C. 6311(20)(A)) However, the current DOE test procedure for walk-in refrigeration systems, which incorporates by reference AHRI 1250–2009, does not address how to test liquid-cooled systems. Additionally, liquid-cooled dedicated condensing units are outside the scope of AHRI 1250–2020, being specifically excluded in section 2.2.4.

In the June 2021 RFI, DOE requested comment on whether it should consider establishing a test procedure for liquid-cooled walk-in equipment. 86 FR 32332, 32334. Lennox, AHRI, Keeprite, National Refrigeration, and Hussmann recommended against establishing a separate test procedure for liquid-cooled refrigeration systems due to the small market size for such systems. (Lennox, No. 9 at p. 2; AHRI, No. 11 at p. 2; Keeprite, No. 12 at p. 1; National

[8] *See* Docket No. EERE–2017–BT–TP–0010–0001, Docket No. EERE–2017–BT–TP–0010–0002, and Docket No. EERE–2017–BT–TP–0010–0003.

Refrigeration, No 17 at p. 1; Hussmann, No. 18 at p. 2) Lennox, AHRI, Keeprite, and Hussmann also explained that the type of coolant used has the most impact on efficiency for liquid-cooled systems; however, coolants are not specified by the WICF system manufacturer. These stakeholders asserted that liquid-cooled systems do not have a large potential for energy savings since purchasers, rather than WICF manufacturers, specify the coolant system. (Lennox, No. 9 at p. 2; AHRI, No. 11 at p. 2; Keeprite, No. 12 at p. 1; Hussmann, No. 18 at p. 2) Keeprite also stated that liquid-cooled systems are generally more efficient than air cooled models. (Keeprite, No. 12 at p. 1)

ASAP recommended developing a test procedure for liquid-cooled systems since the systems are currently available in the market and there are no applicable test procedures. (ASAP, No. 13 at p. 1) ASAP stated that adopting test methods for liquid-cooled systems would provide purchasers with comparable ratings regardless of cooling type. *Id.* Daikin recommended considering EN 17432, ''Packaged refrigerating units for walk-in cold rooms—Classification, performance and energy consumption testing'' (''EN 17432''), which addresses water-cooled and liquid-cooled refrigeration systems. (Daikin, No. 17 at p. 1)

DOE reiterates that the scope of the walk-in definition includes liquid-cooled equipment. DOE recognizes the potential benefit of a test procedure for liquid-cooled walk-ins and the value that a reliable test procedure can provide to facilitate comparable representations of energy use for consumers. DOE has tentatively determined that liquid-cooled refrigeration systems may represent a small portion of the walk-in market and the potential for energy savings is likely limited. Therefore, although liquid-cooled refrigeration systems are considered to be covered equipment, DOE is not proposing to amend its procedures to include liquid-cooled refrigeration systems at this time.

b. Carbon Dioxide Systems

Currently, the DOE test procedure for walk-in refrigeration systems does not explicitly define scope based on refrigerant. *See* 10 CFR 431.301, 10 CFR 431.304, and appendix A. DOE understands that the current test procedure, which is based on AHRI 1250–2009 (incorporated by reference, 10 CFR 431.303(b)), specifies test conditions that may not be consistent with the design and operation of carbon dioxide (''CO_2'') refrigeration systems; *i.e.,* although AHRI 1250–2009 does not specifically exclude CO_2 systems, the test method is not designed to accommodate such systems.

The DOE test procedure for unit coolers requires testing with a liquid inlet saturation temperature of 105 °F and a liquid inlet subcooling temperature of 9 °F, as specified by Tables 15 and 16 of AHRI 1250–2009. However, CO_2 has a critical temperature of 87.8 °F; therefore, it does not coexist as saturated liquid and gas above this temperature. The liquid inlet saturation temperature of 105 °F and the liquid inlet subcooling temperature of 9 °F specified in subpart R, appendix C, are not achievable by CO_2 unit coolers. DOE has granted waivers or interim waivers from subpart R, appendix C, for specific basic models of CO_2 unit coolers to the manufacturers listed in Table III.1 of this document. The alternate test procedure specified in these waivers modified the liquid inlet saturation temperature to 38 °F and the liquid inlet subcooling temperature to 5 °F. Pursuant to its waiver regulations, as soon as practicable after the granting of any waiver, DOE will publish in the **Federal Register** a notice of proposed rulemaking to amend its regulations so as to eliminate any need for the continuation of such waiver. 10 CFR 431.401(l). As soon thereafter as practicable, DOE will publish in the **Federal Register** a final rule to that effect. *Id.*

TABLE III.1—WAIVERS GRANTED TO MANUFACTURERS OF CO_2 WALK-IN REFRIGERATION SYSTEMS

Manufacturer	Interim waiver **Federal Register** citation	Waiver decision and order **Federal Register** citation
Heat Transfer Products Group (''HTPG'')	85 FR 83927 (Dec. 23, 2020)	86 FR 14887 (Mar. 19, 2021).
Hussmann Corporation (''Hussmann'')	86 FR 10046 (Feb. 18, 2021)	86 FR 24606 (May 7, 2021).
Keeprite Refrigeration (''Keeprite'')	86 FR 12433 (Mar. 3, 2021)	86 FR 24603 (May 7, 2021).
RefPlus Inc. (''RefPlus'')	86 FR 43633 (Aug. 10, 2021).	

The alternate test procedure granted in the CO_2 waivers and DOE's proposal with respect to refrigeration systems utilizing CO_2 as a refrigerant are further discussed in section III.F.6 of this document.

As discussed in the June 2021 RFI, all CO_2 refrigerant waiver petitions DOE has thus far received address unit coolers. 86 FR 32332, 32346. However, it is possible that other CO_2 refrigeration system configurations may be relevant in the future, *e.g.* dedicated condensing units, matched pairs, or single-packaged dedicated systems. DOE reviewed product literature and other information for CO_2 systems having some of these alternative configurations. Most of the information identified by DOE pertains to manufacturers operating in Europe.

In the June 2021 RFI, DOE requested comment on the future expected use of walk-in refrigeration systems using CO_2. 86 FR 32332, 32346. Lennox, AHRI, National Refrigeration, and Hussmann stated that they are not aware of any transcritical [9] CO_2 dedicated condensing units available in North America. (Lennox, No. 9 at p. 7; AHRI, No. 11 at p. 12; National Refrigeration, No 17 at p. 1; Hussmann, No. 18 at p. 14) National Refrigeration asserted that CO_2 tends to be used in large, complex multi-compressor systems and therefore, would not be used in smaller systems with just one dedicated condensing unit (National Refrigeration, No. 17 at p. 1) The CA IOUs stated that CO_2 unit coolers cannot be tested and rated at the temperatures and pressures used in the current test procedure for more traditional hydrofluorocarbon (''HFC'') refrigerants; however, single-packaged dedicated CO_2 refrigeration systems should be able to use the test methods established in AHRI 1250–2020 for single-packaged dedicated systems, because these test methods do not use refrigerant flow or refrigerant conditions for energy calculations. (CA IOUs, No. 14 at p. 4) Additionally, the CA IOUs urged DOE to ensure that the WICF test procedures and metrics continue to provide consumers with the information necessary to easily compare the

[9] CO_2 refrigeration systems are transcritical because the high-temperature refrigerant that is cooled by ambient air is in a supercritical state, above the 87.8 °F critical point temperature, above which the refrigerant cannot exist as separate vapor and liquid phases.

performance of products with the same utility. *Id.*

DOE preliminarily finds that, in the North American market, CO_2 is primarily used in large rack systems, and that there do not appear to be any CO_2 dedicated condensing units available. Hence, DOE tentatively finds that adopting a test procedure for CO_2 dedicated condensing units is currently not warranted. However, DOE has also tentatively determined that the test methods in AHRI 1250–2020 for single-packaged dedicated systems do not need to be modified for CO_2 refrigerant as long as these units are tested using air enthalpy or calorimeter test methods, rather than a refrigerant enthalpy method. DOE further discusses its proposals for testing single-packaged dedicated systems in section III.G.2 of this document.

In this NOPR, DOE is proposing that walk-in refrigeration equipment utilizing CO_2 as a refrigerant meet the definition of a walk-in refrigeration system, but that the DOE test procedure, as proposed in this document, would apply only to (1) single-packaged dedicated systems and (2) unit cooler variants of CO_2 refrigeration systems. This proposal would exclude CO_2 dedicated condensing units from the proposed test procedure. The test procedures for CO_2 unit coolers and single-packaged refrigeration systems which use CO_2 as a refrigerant are outlined in more detail in sections III.F.6 and III.G.2.f of this document, respectively.

c. Multi-Circuit Single-Packaged Refrigeration Systems

DOE has received a request for waiver and interim waiver from Refrigerated Solutions Group (''RSG'') from the test procedure in subpart R, appendix C, for basic models of single-packaged dedicated systems having multiple refrigerant circuits within a single unit that share a single evaporator and a single condenser. (Docket EERE–2022–BT–WAV–0010, No. 1) In its petition, RSG stated that the current walk-in test procedure does not address multiple refrigeration circuits that are enclosed in a single unit. *Id.* Therefore, in this test procedure NOPR, DOE has initially determined that refrigeration systems with multiple refrigeration circuits that share a single evaporator and a single condenser and are used in walk-in applications meet the definition of ''walk-in cooler and walk-in freezer.'' Thus, DOE proposes to define ''multi-circuit single-packaged dedicated system'' in section III.A.2.e of this document. Additionally, DOE is proposing a test procedure for such systems.

d. Ducted Units

DOE is aware that some walk-in evaporators and/or dedicated condensing units are sold with provisions to be installed with duct(s) to circulate air between the walk-in and the refrigeration system. The current definition of ''single-packaged dedicated system'' specifies that such systems do not have ''any element external to the system imposing resistance to flow of the refrigerated air;'' and the definition of ''unit cooler'' specifies that such equipment does not have ''any element external to the cooler imposing air resistance.'' (10 CFR 431.302) As such, unit coolers and single-packaged dedicated systems sold for ducted installation are not addressed by either definition—also, the current test procedure does not include provisions for setup of ductwork. While the definition for condensing unit does not exclude systems intended for ducted installation, the current test procedure does not include provisions for setup of ductwork for these components either.

DOE has granted waivers from the test procedure in subpart R, appendix C, to Air Innovations, Vinotheque, Cellar Pro, and Vinotemp, and an interim waiver to LRC Coil, for walk-ins marketed for use as wine cellar refrigeration systems (*see* Table III.2). The waivers are discussed in more detail in sections III.A.2.c and III.G.6 of this document. Relevant to the present discussion of scope, the specific basic models for which waivers have been granted include equipment sold as ducted units. As a result of the test procedure waivers granted by DOE, DOE proposes to revise the single-packaged dedicated system definition to clarify that such systems may have provisions for ducted installation. DOE proposes to add a definition for ''ducted fan coil unit,'' the ducted equivalent of a unit cooler. In doing so, DOE preserves the standard industry definition of a unit cooler while expanding the scope of the test procedure to ducted units. DOE also proposes to add provisions in the test procedures to address setup of ductwork and the external static pressure that it imposes on refrigeration system fans—all in order to improve representativeness of the test procedure. These test procedure revisions are addressed in section III.G.6 of this document.

TABLE III.2—INTERIM WAIVERS AND WAIVERS GRANTED TO MANUFACTURERS OF WALK-INS MARKETED AS WINE CELLAR REFRIGERATION SYSTEMS

Manufacturer	Interim waiver **Federal Register** citation	Waiver decision and order **Federal Register** citation
Air Innovations.	86 FR 2403 (Jan. 12, 2021).	86 FR 23702 (May 4, 2021).
Vinotheque.	86 FR 11961 (Mar. 1, 2021).	86 FR 26504 (May 14, 2021).
CellarPro.	86 FR 11972 (Mar. 1, 2021).	86 FR 26496 (May 14, 2021).
Vinotemp.	86 FR 23692 (May 4, 2021).	86 FR 36732 (July 13,2021).
LRC Coil.	86 FR 47631 (Aug. 26, 2021).	

2. Definitions

a. Walk-in Cooler and Walk-in Freezer

The term ''walk-in cooler and walk-in freezer'' means an enclosed storage space refrigerated to temperatures, respectively, above, and at or below 32 °F, that can be walked into, and has a total chilled storage area of less than 3,000 square feet; however, the term does not include products designed and marketed exclusively for medical, scientific, or research purposes. 10 CFR 431.302. (*See* also 42 U.S.C. 6311(20))

In this notice, DOE proposes to amend the definition of walk-in cooler and freezer to specify that a walk-in may be comprised of doors, panels, and refrigeration systems. As explained in section I.B of this document, DOE established separate test procedures and energy conservation standards for the principal components that make up a walk-in: panels, doors, and refrigeration systems. 76 FR 21580, 21582 and 79 FR 32050, 32051–32052. DOE noted in a final rule published March 7, 2011 (''March 2011 Compliance, Certification, and Enforcement (''CCE'') final rule'') that the legislative design standards set forth in EPCA provide the framework for a component-based approach since each design standard is based on the performance of a given component of the walk-in. 76 FR 12422, 12444. In order to align the definition with the regulatory scheme adopted by DOE, DOE proposes to revise the definition to mean an enclosed storage space, including but not limited to panels, doors, and refrigeration systems, refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit that can be walked into, and has a total chilled storage area of less than 3,000 square feet; however, the terms do not include products designed and marketed exclusively for medical, scientific, or research purposes. DOE does not intend for this amended definition to expand the scope of the definition for walk-in coolers and freezers nor does it intend for this amended definition to expand the certification and compliance responsibilities of entities involved in manufacturing or assembling walk-ins or walk-in components. Instead, DOE's proposed revision to the definition of walk-in cooler and walk-in freezer clarifies that DOE has the authority to separately regulate walk-in components as well as a full walk-in system (including but not limited to panels, doors, and refrigeration systems). The March 2011 CCE final rule adopted a definition for a walk-in manufacturer to specify the entities responsible for certification and/or compliance of walk-ins or walk-in components. 76 FR 12422, 12442–12444. DOE emphasizes that both the component manufacturer and the assembler bear the responsibility of standards compliance, even though the component manufacturer is the entity responsible for certification. An assembler may rely on the certification from the component manufacturer regarding whether the component being used is certified as compliant with DOE standards.

Issue 1: DOE requests comment on its proposed changes to the definition for walk-in cooler and walk-in freezer.

b. Doors

With respect to walk-ins, DOE defines a ''door'' as an assembly installed in an opening on an interior or exterior wall that is used to allow access or close off the opening and that is movable in a sliding, pivoting, hinged, or revolving manner of movement. For walk-in coolers and walk-in freezers, a door includes the door panel, glass, framing materials, door plug, mullion, and any other elements that form the door or part of its connection to the wall. 10 CFR 431.302. In the June 2021 RFI, DOE requested feedback on the current definition of ''door.'' 86 FR 32332, 32335.

Hussmann stated that the current definition of door is sufficient. (Hussmann, No. 18 at p. 3) Anthony and AHRI stated that ''door'' is unclear and inadequately defined. (Anthony, No. 8 at p. 1; AHRI, No. 11 at p. 2) AHRI commented that the current definition seems to describe an individual ''door'' opening, but that the requirement for testing uses the opening space in the walk-in regardless of whether it contains more than one ''door'' opening. AHRI suggested that the definition of ''door'' should contain the door frame and all door components, and that DOE should differentiate between the number of openings for a specific door assembly inserted into the opening space, especially for display doors. (AHRI, No. 11 at pp. 2–3) Anthony asserted that any component that is part of the door assembly (*e.g.,* door, frame, wiring) is within the definition of a WICF door. (Anthony, No. 8 at pp. 1–2)

In the June 2021 RFI, DOE also requested comment specifically on the use of the term ''door plug'' within the definition of ''door.'' 86 FR 32332, 32335. Anthony and AHRI stated that they were unfamiliar with the term ''door plug.'' (Anthony, No. 8 at pp. 1–2; AHRI, No. 11 at pp. 2–3) Imperial Brown stated that the door plug is the moving part of the door that can swing or slide and comes attached to the frame. (Imperial Brown, No. 15 at p. 1) Hussmann stated that the term ''door plug'' is in reference to a regular door plug (*i.e.,* plugging heaters from a door to a frame system), and that Hussmann does not use the term ''door plug'' interchangeably with a ''door.'' (Hussmann, No. 18 at p. 3)

DOE recognizes that the current definition of ''door'' does not explicitly address that walk-in door assemblies may contain multiple door openings within one frame. DOE also notes that NFRC 100 includes several defined terms relating to door components (*e.g.,* door leaf), which differ from the terms used in DOE's definition of ''door.'' Additionally, certain stakeholders commented that they are unfamiliar with the term ''door plug,'' whereas others use it to describe different components of the door assembly.

DOE proposes to amend the definition of ''door'' to address doors with multiple openings within one frame; to include terminology that generally aligns with terminology used by the industry; and to remove use of the term ''door plug,'' which is being interpreted inconsistently by stakeholders. Specifically, DOE proposes to amend the definition of ''door'' to mean an assembly installed in an opening of an interior or exterior wall that is used to allow access or close off the opening and that is movable in a sliding, pivoting, hinged or revolving manner of movement. For walk-in coolers and walk-in freezers, a door includes the frame (including mullions), the door leaf or multiple door leaves (including glass) within the frame, and any other elements that form the assembly or part of its connection to the wall. DOE also proposes to define the term ''door leaf'' to mean the pivoting, rolling, sliding, or swinging portion of a door. DOE tentatively concludes that the proposed revision of ''door'' and proposed definition of ''door leaf'' better align with industry terminology and address doors with multiple openings within one frame. DOE does not intend for the proposed changes to the definition of ''door'' and the newly defined term for ''door leaf'' to change the scope of applicability of the DOE test procedures or the applicability of standards for walk-in doors.

As discussed in the June 2021 RFI, DOE differentiates WICF doors by whether such doors are ''display doors'' or not display doors (*i.e.,* ''passage doors'' or ''freight doors''). 86 FR 32332, 32335. A ''freight door'' is a door that is not a display door and is equal to or larger than 4 feet wide and 8 feet tall. 10 CFR 431.302. A ''passage door'' is a door that is not a freight or display door. *Id.* The use of dimensions in the definition of freight door conveys that these doors typically allow large machines (*e.g.,* forklifts) to pass through carrying freight. However, the definition does not address instances where one dimension exceeds the height or width requirement per the definition, but the other dimension is smaller than the other dimension requirement per the definition. In some cases, the surface area for such doors could be larger than 32 square feet, the area of a 4-foot by 8-foot door provided in the definition (*e.g.,* a door 5 feet wide and 7 feet tall, with a surface area of 35 square feet); in other cases, the surface area could be smaller than 32 square feet (*e.g.,* a door 5 feet wide and 6 feet tall, with a surface area of 30 square feet). As part of the June 2021 RFI, DOE reviewed the certified surface areas of freight and passage doors in DOE's Compliance Certification Management System (''CCMS'') Database. DOE found that many models certified as passage doors had rated surface areas greater than or equal to 32 square feet while some models certified as freight doors had rated surface areas less than 32 square feet. 86 FR 32332, 32335.

In the June 2021 RFI, DOE requested comment on whether height and width or surface area effectively distinguish between passage and freight doors and whether there are any building codes, standards, or industry practices to support or refute maintaining dimensions of a door as the defining characteristics separating freight and passage doors. Additionally, DOE sought comment on any other attributes other than size which would appropriately distinguish passage and freight doors. Lastly, DOE sought comment on how to classify non-display doors with multiple openings where the individual door openings do not meet the definition of freight door, but the overall door assembly would meet the definition of a freight door per the dimension requirements in the freight door definition. *Id.*

The CA IOUs generally supported DOE updating its definitions related to walk-in doors to prevent mis-categorization. Specifically, the CA IOUs suggested that DOE align with industry definitions for freight doors, such as vertical or sectional overhead doors, and consider differentiating doors based on opening characteristics (*e.g.,* swing, horizontal slide, vertical slide, rollup) rather than size. (CA IOUs, No. 14 at p. 5)

Imperial Brown stated that the door width-in-clear [10] (or ''WIC'') should be the determining factor for distinguishing passage and freight doors. Imperial Brown recommended that a freight door be identified as a door with a WIC of 48 inches or more and a height-in-clear [11] (''HIC'') of 78 inches or more, allowing for pallet and forklift traffic. (Imperial Brown, No. 15 at p. 1)

AHRI stated that the current area cut-off of 4 feet by 8 feet is sufficient for distinguishing between passage and freight doors. AHRI stated that there are no specific dimensions that distinguish freight from passage doors and that the dimensions tend to be application specific. AHRI also commented that generally the height of passage and freight doors are similar, but that the width varies. (AHRI, No. 11 at p. 3)

Regarding other characteristics that may distinguish passage and freight doors, both Anthony and Hussmann stated that they define passage doors and freight doors by whether the door is provided for personnel access to the WICF (*i.e.,* passage doors) or provided for stocking of product with the use of equipment (*i.e.,* freight doors). (Anthony, No. 8 at p. 2; Hussmann, No. 18 at pp. 3–4) Hussmann stated that passage doors must be large enough for individuals to pass through and meet requirements established by the Americans with Disabilities Act (''ADA''). (Hussmann, No. 18 at pp. 3–4)

Regarding non-display doors that contain multiple openings, AHRI and Hussmann commented that it is not necessary to change how non-display doors with multiple openings are classified. (AHRI, No. 11 at p. 3; Hussmann, No. 10 at p. 4) Imperial Brown stated that non-display doors with multiple openings should be considered freight doors only if they have an unobstructed WIC by HIC (*i.e.,* there are no mullions in the opening) that meets the freight door dimensional requirements. (Imperial Brown, No. 15 at p. 1)

Considering the comments received, DOE is not proposing to revise the definition of ''freight door'' at this time.

DOE is proposing to define the term ''non-display door.'' Although the test procedures outlined in 10 CFR 431.304 and appendices A and B use the term ''non-display door,'' it is not currently defined. The proposed definition would provide that a ''non-display door'' would mean a door that is not a display door.

Based on the input it has received, DOE has tentatively determined that differentiating walk-in doors based on opening characteristics would better align with industry terminology. Therefore, DOE is proposing to define three terms, which include some industry terminology identified in NFRC 100, to further differentiate among both display and non-display doors: ''Hinged vertical door,'' ''roll-up door,'' and ''sliding door'' (see proposed definitions set out in the regulatory text at the end of the document, proposed § 431.302).

Issue 2: DOE requests feedback on the proposed changes to the definition of ''door'' and the newly proposed definition for ''door leaf.'' DOE also seeks comment on the newly proposed definitions for certain door opening characteristics: ''Hinged vertical door,'' ''roll-up door,'' and ''sliding door.''

c. High-Temperature Refrigeration Systems

As discussed previously, DOE has granted several manufacturers waivers and interim waivers from the test procedure in subpart R, appendix C, for basic models of refrigeration systems marketed as wine cellar refrigeration systems (*see* section III.A.1.d). These manufacturers stated that walk-ins used for wine storage are intended to operate at a temperature range of 45 to 65 °F and 50–70 percent relative humidity, rather than the 35 °F and less than 50 percent relative humidity test condition prescribed in subpart R, appendix C.

In the June 2021 RFI, DOE requested comment on how refrigeration systems marketed as wine cellar refrigeration systems should be defined to best represent the conditions under which these systems are designed to operate. 86 FR 32332, 32334–32335. AHRI, Lennox, and the CA IOUs recommended that DOE adequately define refrigeration systems marketed as wine cellar refrigeration systems and evaluate them as a separate efficiency class. (Lennox, No. 9 at p. 6; AHRI, No. 11 at p. 11; CA IOUs, No. 14 at pp. 3–4) AHRI and Hussmann suggested that refrigeration systems marketed as wine cellar refrigeration systems be defined as an enclosed storage space designed to be cooled to between 45 °F and 65 °F with a relative humidity range of 50 percent to 70 percent, and typically kept at 55 °F and 55% RH. (AHRI, No. 11 at p. 2; Hussmann, No. 18 at p. 3) Daikin stated that refrigeration systems marketed as wine cellar refrigeration systems operate between 37.4 °F and 68 °F, and between 70% and 85% relative humidity. (Daikin, No. 17 at p. 2)

In the June 2021 RFI, DOE also requested feedback on walk-in applications other than wine cellar cooling that may have a target room temperature of 35 °F and higher. 86 FR 32332, 32334–32335. Lennox, AHRI and Hussmann each stated that wine cellars are the only walk-in applications with a temperature range between 45 °F and 65 °F and with a relative humidity between 50 percent and 70 percent. (Lennox, No. 9 at p. 2; AHRI, No. 11 at p. 2; Hussmann, No. 18 at pp. 2–3) Daikin stated by way of example that florist coolers operate at 68 °F and between 90% to 95% humidity. (Daikin, No. 17 at p. 2)

DOE understands from these comments that there are walk-in applications other than wine cellars that require cooling to temperatures higher than 35 °F. To provide for testing of such walk-ins using test conditions that result in measurements of energy use in a representative average-use cycle DOE proposes to define walk-ins designed to operate at cooling temperatures above 45 °F as employing a ''high-temperature refrigeration system''—which would mean a walk-in refrigeration system which is not designed to operate below 45 °F.'' The proposed definition would provide for the testing of such units using specified conditions representative of their average use, *i.e.,* cooling the refrigerated space to a temperature above 45 °F. See the corresponding test procedure provisions proposed in section III.G.6 for further details.

d. Ducted Fan Coil Units

DOE has granted waivers to Air Innovations, Vinotheque, Cellar Pro, and Vinotemp, and an interim waiver to LRC Coil for walk-ins that are marketed

[10] Imperial Brown defined WIC as the clear opening width, typically from left frame jamb to right frame jamb. (Imperial Brown, No. 15 at p. 1)

[11] Imperial Brown defined HIC as the clear opening height, typically from door sill to frame header. (Imperial Brown, No. 15 at p. 1)

as wine cellar refrigeration systems that are designed and marketed as ducted units. (*See* Table III.2) The definitions for single-packaged units and unit coolers currently exclude ducted units, resulting in the lack of a test procedure for such units. 10 CFR 431.302. Specifically, the current single-packaged unit definition excludes units with ''any element external to the system imposing resistance to flow of the refrigerated air.'' Similarly, the current unit cooler definition specifically excludes units with ''element[s] external to the cooler imposing air resistance.'' *Id.*

In the June 2021 RFI, DOE requested comment on changing the ''single-packaged dedicated system'' and ''unit cooler'' definitions to address units that are designed to be installed with ducts. 86 FR 32332, 32346. Lennox and AHRI both stated that the ASHRAE 210P committee[12] is working to define a ''ducted unit cooler'' and is currently considering defining it as ''an assembly, including means for forced air circulation, capable of moving air against both internal and non-zero external flow resistance, and elements by which heat is transferred from air to refrigerant to cool the air, with provision for ducted installation.'' (Lennox, No. 9 at p. 6; AHRI, No. 11 at p. 11) Lennox and AHRI both urged DOE to work with the ASHRAE 210P committee to find an appropriate solution. (Lennox, No. 9 at p. 7; AHRI, No. 11 at p. 12)

To clarify that refrigeration systems that have provision for ducted installation are indeed included in the DOE test procedure, DOE is proposing an appropriate term and a definition for the term ''ducted unit cooler'' mentioned by commenters and is also proposing to revise the definition for single-packaged dedicated system to clarify that such a system can have provision for ducted installation. DOE proposes to adopt the new term, ''ducted fan-coil unit,'' which would be defined as an assembly including means for forced air circulation capable of moving air against both internal and non-zero external flow resistance, and elements by which heat is transferred from air to refrigerant to cool the air, with provision for ducted installation. DOE is also proposing to revise the current single-packaged dedicated system definition to mean a refrigeration system (as defined in 10 CFR 431.302) that is a single-packaged assembly that includes one or more compressors, a condenser, a means for forced circulation of refrigerated air, and elements by which heat is transferred from air to refrigerant.

Issue 3: DOE requests comment on the proposed definition of ''ducted fan coil unit'' and on the proposed modification to the ''single-packaged dedicated system'' definition.

e. Multi-Circuit Single-Packaged Refrigeration Systems

As discussed in section III.A.1.c, DOE is proposing to include a test procedure for evaluating the energy consumption of single-packaged units that contain multiple refrigeration circuits. As discussed, these units differ from larger multi-circuit refrigeration systems in that the refrigeration circuits are housed within an assembly and share a single condenser and a single evaporator. DOE proposes to define a ''multi-circuit single-packaged refrigeration system'' as a single-packaged dedicated system (as defined in 10 CFR 431.302) that contains two or more refrigeration circuits that refrigerate a single stream of circulated air.

Issue 4: DOE requests comment on the proposed definition for multi-circuit single-packaged dedicated refrigeration systems.

f. Attached Split Systems

DOE is aware of some refrigeration systems that are sold as matched pairs in which the dedicated condensing unit and unit cooler are permanently attached to each other with structural beams. When these units are mounted to the refrigerated box, these beams extend through the wall of the walk-in, connecting the unit cooler inside the refrigerated box with the dedicated condensing unit outside the refrigerated box. The functionality of an attached split system may be similar to that of a matched pair system but may also have similarities to a single-packaged dedicated system, since they are single assemblies. The DOE test procedure does not currently define such systems, nor does it provide any unique test provisions for them—thereby affecting the ability of manufacturers to provide test results reflecting the energy efficiency of this equipment during a representative average use cycle. DOE discusses its proposal for testing such units in section III.G.4 of this document. DOE has initially determined that attached split systems are a type of matched pair system and proposes to define these systems as matched pair refrigeration systems designed to be installed with the evaporator entirely inside the walk-in enclosure and the condenser entirely outside the walk-in enclosure, and the evaporator and condenser are permanently connected with structural members extending through the walk-in wall.

Issue 5: DOE requests comment on the proposed definition for attached split system.

g. Detachable Single-Packaged System

DOE is aware of some refrigeration systems that are designed to be installed with the evaporator unit exchanging air through the wall or ceiling of the walk-in as would be the case in a single-packaged system, but with the condensing unit installed either next to the evaporator unit or installed remotely and connected to the evaporator with refrigerant lines as is done in split systems. The current DOE test procedure does not define such systems or provide testing provisions specific to this configuration. DOE discusses its proposal for testing such units in section III.G.3 of this document. DOE has initially determined that these units are a type of single-packaged dedicated system, and proposes to define a detachable single-packaged system as a system consisting of a dedicated condensing unit and an insulated evaporator section in which the evaporator section is designed to be installed external to the walk-in enclosure and circulating air through the enclosure wall, and the condensing unit is designed to be installed either attached to the evaporator section or mounted remotely with a set of refrigerant lines connecting the two components.

Issue 6: DOE requests comment on the proposed definition for detachable single-packaged dedicated system.

h. CO_2 Unit Coolers

As discussed in section III.A.1.b, DOE is proposing to adopt test procedures for unit coolers designed for use in CO_2 refrigeration systems, these proposals are discussed in detail in section III.F.6 of this document. CO_2 systems are designed and built to operate using CO_2 as a refrigerant, which has the potential to reach pressures much higher than conventional refrigerants. With the air enthalpy test method, CO_2 single-packaged refrigeration systems would use the same test methods as conventional-refrigerant single-packaged dedicated systems (*see* DOE's proposal discussed in section III.G.2.f). However, the proposed test procedure for CO_2 unit coolers would alter the inlet refrigerant test conditions as compared to conventional refrigerants (*see* section III.F.6). To clarify the scope

[12] The American Society of Heating, Refrigerating and Air-Conditioning Engineers (''ASHRAE'') has formed the ASHRAE Standard Project Committee 210 (''ASHRAE 210P'') to evaluate and revise its ''Method of Testing and Rating Commercial Walk-in Refrigerators and Freezers.'' *See spc210.ashraepcs.org/.*

of the proposed unit cooler test procedure, DOE is proposing to define a CO_2 unit cooler as one that includes a nameplate listing only CO_2 as an approved refrigerant.

Issue 7: DOE requests comment on the proposed definition of CO_2 unit coolers. DOE also requests comment on whether any distinguishing features of CO_2 unit coolers exist that could reliably be used as an alternative approach that can differentiate them from those unit coolers intended for use with conventional refrigerants.

i. Hot Gas Defrost

As discussed previously, DOE published a final rule that amended the test procedure to rate hot gas defrost unit coolers using the modified default values for energy use and heat load contributions in AHRI 1250–2020. 86 FR 16027. At that time, DOE did not adopt a definition for ''hot gas defrost.'' However, as discussed in more detail in section III.G.8.b, DOE is proposing that equipment with hot gas defrost installed at the factory may be marketed using representations of performance with hot gas defrost activated. This would be a voluntary representation by the manufacturer. To ensure that the scope of this voluntary representation is clear, DOE is proposing to define ''hot gas defrost'' as a factory-installed system where refrigerant is used to transfer heat from ambient outside air, the compressor, and/or a thermal storage component that stores heat when the compressor is running and uses this stored heat to defrost the evaporator coils.

Issue 8: DOE requests comment on the proposed definition for hot gas defrost. Specifically, DOE requests comment on if this proposed definition is sufficient to identify which equipment is sold with hot gas defrost capability installed and which is not.

B. Industry Standards

The current DOE test procedure for walk-in coolers and freezers incorporates the following industry test standards: NFRC 100–2010 into appendix A; ASTM C518 into appendix B; and AHRI 1250–2009, AHRI 420–2008,[13] and ASHRAE 23.1–2010[14] into subpart R, appendix C. The following sections detail the industry standards DOE is proposing to incorporate by reference in the NOPR and the relevant provisions of those industry standards that DOE is proposing to adopt.

1. Standards for Determining Thermal Transmittance (U-Factor)

Appendix A references NFRC 100 as the method for determining the U-factor of doors and display panels. NFRC 100 allows for computational determination of U-factor by simulating U-factor using Lawrence Berkeley National Lab's (''LBNL'') WINDOW and THERM software, provided that the simulated value for the baseline product in a product line is validated with a physical test of that baseline product and the simulated value is within the accepted agreement with the physical test value as specified in section 4.7.1 of NFRC 100.[15] Section 4.3.2.1 of NFRC 100 references NFRC 102–2010, ''Procedure for Measuring the Steady state Thermal Transmittance of Fenestration Systems'' (''NFRC 102–2010''), as the physical test procedure for determining U-factor. NFRC 102–2010 is based on ASTM C1199–09, ''Standard Test Method for Measuring the Steady state Thermal Transmittance of Fenestration Systems Using Hot Box Methods'' (''ASTM C1199–09'') with some modifications.

Since DOE adopted this test procedure for determining U-factor of doors and display panels in 2011, NFRC has published updates to NFRC 102, the most recent being NFRC 102–2020, which supersedes all previous versions of NFRC 102. The following are the identified substantive changes and additions in NFRC 102–2020 as compared to NFRC 102–2010, which is referenced in the current Federal test procedure via NFRC 100–2010:

1. Added a list of required calibrations for primary measurement equipment, including metering box wall transducer and surround panel flanking loss characterization and annual verification procedure, and incorporated a calibration transfer standard (''CTS'') calibration continuous characterization procedure; and

2. The provisions regarding air velocity distribution were revised to be more specific to the type of fans used.

Additionally, NFRC 102–2020 references the updated version of ASTM C1199 (ASTM C1199–14) instead of ASTM C1199–09. Based on a review of ASTM C1199–14, DOE has tentatively determined that the differences between editions are editorial.

DOE is proposing to adopt by reference in appendix A, the following sections of NFRC 102–2020 for determining U-factor:

- 2. Referenced Documents,
- 3. Terminology,
- 5. Apparatus,
- 6. Calibration,
- 7. Experimental Procedure (excluding 7.3. Test Conditions),
- 8. Calculation of Thermal Transmittance,
- 9. Calculation of Standardized Thermal Transmittance,
- Annex A1. Calibration Transfer Standard Design,
- Annex A2. Radiation Heat Transfer Calculation Procedure, and
- Annex A4. Garage Panel and Rolling Door Installation.

DOE is also proposing to incorporate by reference ASTM C1199–14, as it is referenced in NFRC 102–2020. Specifically, in the proposed test procedure in appendix A, DOE is proposing to reference the following sections of ASTM C1199–14 as referenced through NFRC 102–2020: Sections 2, 3, 5, 6, 7 (excluding 7.3), 8, 9, and Annexes A1 and A2. DOE is not proposing to reference any other sections of NFRC 102–2020 or ASTM C1199–14 as they either do not apply or they are in direct conflict with other test procedure provisions included in the subpart R.

2. Standard for Determining R-Value

As mentioned previously, section 4.2 of appendix B references ASTM C518 to determine the thermal conductivity, or K-factor, of panel insulation. EPCA requires that the measurement of the K-factor used to calculate the R-value be based on ASTM C518–2004 (''ASTM C518–04''). (42 U.S.C. 6314(a)(9)(A)(ii)) In December 2015, ASTM published a revision of this standard (''ASTM C518–15''). ASTM C518–15 removed references to ASTM Standard C1363, ''Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus'' (''ASTM C1363''), and added references to ASTM Standard E456, ''Terminology Relating to Quality and Statistics.'' Additionally, ASTM C518–15 relies solely on the International System of Units (''SI units''), with paragraph 1.13 clarifying that these SI unit values are to be regarded as standard. In July 2017, ASTM published another revision of ASTM C518 (''ASTM C518–17''). ASTM

[13] AHRI 420–2008, ''Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration'' (''AHRI 420–2008'').

[14] ANSI/ASHRAE 23.1–2010, ''Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant'' (''ASHRAE 23.1–2010'').

[15] Section 4.7.1 of NFRC 100 requires that the accepted difference between the tested U-factor and the simulated U-factor be (a) 0.03 Btu/(h-ft^2-°F) for simulated U-factors that are 0.3 Btu/(h-ft^2-°F) or less, or (b) 10 percent of the simulated U-factor for simulated U-factors greater than 0.3 Btu/(h-ft^2-°F). This agreement must match for the baseline product in a product line. Per NFRC 100, the baseline product is the individual product selected for validation; it is not synonymous with ''basic model'' as defined in 10 CFR 431.302.

C518–17 added a summary of precision statistics from an interlaboratory study from 2002–2004 in section 10 ''Precision and Bias.''

As part of the June 2021 RFI, DOE requested comment on what issues, if any, would be present if DOE were to adopt the most current version of the standard, ASTM C518–17, for measuring panel K-factor. 86 FR 32332, 32336. NFRC stated that the updates to ASTM C518–17 as compared to what is in ASTM C518–04 would have no substantial impact on the results of testing and no impact on test burden. NFRC also stated that adopting ASTM C518–17 would bring DOE test procedures in line with current industry methods and practice. (NFRC, No. 10 at p. 2) DOE did not receive any additional comments on potentially adopting ASTM C518–17 for measuring panel K-factor.

DOE has tentatively determined that the updates to ASTM C518–2004 (the version of the industry test procedure specified by EPCA as the basis for calculating the K-factor) made in 2015 and 2017 do not substantively change the test method nor would adoption of the latest version in the DOE test procedure increase test burden. Therefore, DOE is proposing to amend its test procedure for determining R-value of insulation for non-display doors and panels by incorporating by reference ASTM C518–17. Specifically, in the proposed test procedure in appendix B, DOE is proposing to reference the following sections of ASTM C518–17:

- 2. Referenced Documents,
- 3. Terminology,
- 5. Apparatus,
- 6. Calibration,
- 7. Test Procedures (excluding 7.3. Specimen Conditioning),
- 8. Calculation, and
- Annex A1. Equipment Design.

DOE is not proposing to reference any other sections of ASTM C518–17 as they either do not apply or they are in direct conflict with other test procedure provisions included in subpart R. As ASTM C518–17 is an updated version of ASTM C518–2004, the DOE test procedure for determining the K-value remains based on ASTM C518–2004.

3. Standards for Determining AWEF

DOE's current test procedure for WICF refrigeration systems is codified in appendix C to subpart R of part 431 and incorporates by reference AHRI 1250–2009, AHRI 420–2008, and ASHRAE 23.1–2010. AHRI 1250–2009 is the industry test standard for refrigeration systems for walk-in coolers and freezers, including unit coolers and dedicated condensing units sold separately, as well as matched pairs. 81 FR 95758, 95798.[16] The procedure describes the method for measuring the refrigeration capacity and the electrical energy consumption for a condensing unit and a unit cooler, including off-cycle fan and defrost subsystem contributions. Using the refrigeration capacity and electrical energy consumption, AHRI 1250–2009 provides a calculation methodology to compute AWEF, the applicable energy-performance metric for refrigeration systems.

The DOE test procedure for walk-in refrigeration systems adopts by reference the test procedure in AHRI 1250–2009 (excluding Tables 15 and 16), with certain enumerated modifications. Generally, DOE's modifications to AHRI 1250–2009 address specific test conditions, tolerances, and instrumentation requirements, as well as specific instructions for how to address defrost energy use, unit coolers tested alone, and dedicated condensing units tested alone. *See* appendix C to subpart R of part 431.

In 2014, AHRI published an update to AHRI Standard 1250 (''AHRI 1250–2014'') which supersedes AHRI 1250–2009. After publication of AHRI 1250–2014, DOE and other stakeholders supported the AHRI 1250 committee in its update of AHRI Standard 1250. Subsequently, in April 2020, AHRI published AHRI 1250–2020, which supersedes AHRI 1250–2014. AHRI 1250–2020 incorporates many of the modifications and additions to AHRI 1250–2009 that DOE currently prescribes in its test procedure. It also includes test methods for unit coolers and dedicated condensing units tested alone, rather than incorporating by reference updated versions of AHRI 420–2008 and/or ASHRAE 23.1–2010, and also includes test methods for single-packaged dedicated systems. Sections III.B.3.a to III.B.3.d detail the changes made to AHRI 1250–2020 as compared to AHRI 1250–2009.

In the June 2021 RFI, DOE requested comment on what issues, if any, would be present if DOE were to adopt AHRI 1250–2020 into the DOE test procedure. 86 FR 32332, 32336. The CA IOUs and NEEA stated their general support for the adoption of AHRI 1250–2020. (CA IOUs, No. 14 at p. 1; NEEA, No. 16 at pp. 1–2) Lennox, AHRI, and Hussmann supported the adoption of AHRI 1250–2020 with some reservations associated with the retest burden it may create. (Lennox, No. 9 at p. 2; AHRI, No. 11 at p. 4; Hussmann, No. 18 at p. 6) Lennox, AHRI, and Hussmann asked DOE to evaluate if a full revision of the test standards was appropriate at this time. (Lennox, No. 9 at p. 2; AHRI, No. 11 at p. 4; Hussmann, No. 18 at p. 6) DOE acknowledges the potential burden of a new test procedure and notes that a full cost evaluation of the proposed test procedure changes has been conducted and is discussed in section III.J. Therefore, DOE is proposing two sets of changes for the refrigeration system test procedure. One set of changes would be included as proposed revisions to subpart R, appendix C, and the other group would be proposed through the establishment of an appendix C1. DOE has tentatively determined that the changes to subpart R, appendix C, would not affect AWEF ratings and therefore not require retesting or recertification. These proposed changes, if adopted, would be required 180 days after the test procedure final rule is published. DOE has also tentatively determined that the proposed provisions included in appendix C1 would affect the determination of energy use and would therefore require retesting and recertification of the proposed AWEF2. The provisions proposed in appendix C1, if adopted, would be required to be followed in conjunction with the compliance date of any amended energy conservation standards that DOE may end up adopting as part of a separate standards rulemaking.

In this test procedure NOPR DOE is proposing to reference AHRI 1250–2020 for use in appendix C1, but excluding:

- Section 1 Purpose,
- Section 2 Scope,
- Section 9 Minimum Data Requirements for Published Ratings,
- Section 10 Marking and Nameplate Data,
- Section 11 Conformance Conditions, and
- Section C10.2.1.1 Test Room Conditioning Equipment under section C10—Defrost Calculation and Test Methods.

DOE is not proposing to reference these sections of AHRI 1250–2020 since they either do not apply or conflict with other test procedure provisions included in the proposed appendix C1. Additionally, DOE is not proposing to reference ASHRAE 23.1–2010 or AHRI 420–2008 in the proposed appendix C1, as the materials referenced in these standards by AHRI 1250–2009 are now included within AHRI 1250–2020.

[16] Available at *www.ahrinet.org.* AHRI 1250–2009 incorporates by reference AHRI 420–2008 for testing of unit coolers and ASHRAE 23–2005 for testing of dedicated condensing units. DOE has updated the reference for the latter test standard to ASHRAE 23.1–2010.

Further, DOE is proposing to reference ASHRAE 16–2016 in the proposed appendix C1, as it is referenced in AHRI 1250–2020, but excluding:

- Section 1 Purpose
- Section 2 Scope
- Section 4 Classifications
- Normative Appendices E–M
- Informative Appendices N–R

DOE is not proposing to reference these sections of ASHRAE 16–2016 as they either do not apply or conflict with other test procedure provisions that would be included as part of the newly proposed appendix C1.

Similarly, DOE is proposing to reference ASHRAE 37–2009 in the proposed appendix C1, as it is referenced in AHRI 1250–2020, but excluding:

- Section 1 Purpose,
- Section 2 Scope,
- Section 4 Classifications,
- Informative appendix A Classifications of Unitary Air-conditioners and Heat Pumps.

DOE is not proposing to reference these sections of ASHRAE 37–2009 as they either do not apply or conflict with other test procedure provisions that would be included as part of the newly proposed appendix C1.

a. Changes Consistent With Subpart R, Appendix C

As mentioned previously, AHRI 1250–2020 incorporates many of the modifications and additions to AHRI 1250–2009 that DOE currently prescribes in its test procedure. The modifications in the following sections of subpart R, appendix C, were incorporated into AHRI 1250–2020. Thus, if DOE were to adopt AHRI 1250–2020, DOE would remove the following sections from subpart R, appendix C:

- Section 3.1.1, which modifies Table 1 (Instrumentation Accuracy) in AHRI 1250–2009;
- Section 3.1.2, which provides guidance on electrical power frequency tolerances;
- Section 3.1.3, which states that in Table 2 of AHRI 1250–2009, the test operating tolerances and test condition tolerances for air leaving temperatures shall be deleted;
- Section 3.1.4, which states that in Tables 2 through 14 in AHRI–1250–2009, the test condition outdoor wet bulb temperature requirement and its associated tolerance apply only to units with evaporative cooling;
- Section 3.1.5, which provides tables to use in place of AHRI 1250–2009 Tables 15 and 16, which are excluded from the IBR in 10 CFR 431.303. The update in AHRI 1250–2020 to Tables 15 and 16 would allow DOE to incorporate the AHRI 1250–2020 tables by reference if DOE were to adopt AHRI 1250–2020;
- Section 3.2.1, which provides specific guidance on how to measure refrigerant temperature;
- Section 3.2.2, which removes the requirement to perform a refrigerant composition and oil concentration analysis;
- Section 3.2.4, which provides voltage requirements for unit cooler fan power measurements;
- Section 3.2.5, which provides insulation and configuration requirements for liquid and suction lines used for testing;
- Section 3.3.1, which gives direction for how to test and rate unit coolers tested alone;
- Section 3.3.2, which clarifies that the 2008 version of AHRI Standard 420 should be used for unit coolers tested alone;
- Section 3.3.3, which modifies the allowable reduction in fan speed for off-cycle evaporator testing;
- Section 3.4.1, which specifies that the 2010 version of ASHRAE 23.1 should be used and that ''suction A'' condition test points should be used when testing dedicated condensing units and,
- Section 3.5, which provides guidance on how to rate refrigeration systems with hot gas defrost.

The entirety of section 3.4.2 of subpart R, appendix C, which provides instruction on how to calculate AWEF and net capacity for dedicated condensing units, would also be removed if AHRI 1250–2020 were to be adopted, but the text in AHRI 1250–2020 that would replace it alters the text currently in section 3.4.2, which would result in a change to the current test procedure.

b. CFR Language Not Adopted in AHRI 1250–2020

As mentioned previously, AHRI 1250–2020 incorporates many, but not all, of the modifications and additions to AHRI 1250–2009 that DOE currently prescribes in its test procedure. For example, section 3.2.3, which modifies the requirements in Section C3.4.5 of AHRI 1250–2009 to require only a sight glass and a temperature sensor located on the tube surface under the insulation to verify sub-cooling downstream of mass flow meters, was not incorporated into AHRI 1250–2020. DOE is proposing, however, to carry over this section into the newly proposed appendix C1.

With respect to other current sections in subpart R, appendix C, sections that were not adopted by AHRI 1250–2020, DOE is proposing to revise those sections as part of this NOPR in the following manner:

- Sections 3.3.4 and 3.3.5, which modify the defrost test procedure in AHRI 1250–2009, would not be carried over into the newly proposed appendix C1. This NOPR proposes a revised approach to account for defrost heat load and energy use. This topic and DOE's proposals are discussed in sections III.G.8.a and III.G.8.b; and
- Section 3.3.7, which provides guidance on how to rate refrigeration systems with variable-speed evaporator fans would also not be carried over into the newly proposed appendix C1.

c. Changes That May Impact the Determination of AWEF

Several changes in AHRI 1250–2020 may impact the AWEF calculation. These changes can be grouped into five categories, discussed in the following paragraphs: Off-cycle tests, single-packaged dedicated systems, defrost calculations, variable capacity, and unit coolers.

Off-Cycle Tests

AHRI 1250–2020 updated the off-cycle tests in Sections C3.5 and C4.2 such that the total input wattage of the test unit is measured during the off cycle, rather than just the unit cooler fan input wattage. This change accounts for ancillary power from components such as crank case heaters and would deliver more representative off-cycle power results. As a result, if DOE were to incorporate this provision into its test procedure, it would affect the AWEF measurement for dedicated condensing units, matched pairs, and single-packaged dedicated systems by accounting for additional energy usage in the measured off-cycle power consumption value. In addition, updates made in AHRI 1250–2020 require that the measurement of unit cooler off-cycle power include the total electric power input to pan heaters and controls as well as the fan motors. AHRI 1250–2020 requires that off-cycle fan speed be at least 50% of full speed or that duty cycle for cycling fans be at least 50%, consistent with the current requirements of section 3.3.3 of subpart appendix C.

Single-Packaged Units

AHRI 1250–2020 added Section C9.1, which includes test methods for single-packaged refrigeration units. These methods allow for testing of single-packaged units with indoor and outdoor air enthalpy methods as specified in ASHRAE 37 and ASHRAE 16. These methods account for the heat leakage that single-packaged dedicated systems are prone to experience by design. The inclusion of this heat leakage would lower single-packaged dedicated systems' net capacities and therefore lower their AWEFs. It would also make their net capacities more representative of field performance.

Defrost Calculations

AHRI 1250–2020 combined the defrost calculations and test methods into Section C10 to AHRI 1250–2020. For systems using electric defrost, the defrost calculations for defrost heat contributed to the box load (Q_{DF}) have been changed to three different equations depending on the system's gross capacity. In addition, new calculation methods for estimating the defrost energy of units with hot gas defrost have been added. The new default equations for electric and hot gas defrost heat and energy contributions are based on testing and analysis work conducted by AHRI and DOE, and therefore these values are expected to be more representative than previous equations for the default values.

AHRI 1250–2020 also added two optional challenge [17] tests for adaptive and hot gas defrost in appendices E and F, respectively. Both tests evaluate whether a unit has a system that functions as either an adaptive or hot gas defrost system. For compliance purposes, DOE requires that units are tested without activating adaptive defrost or hot gas defrost; therefore, neither challenge test included in AHRI 1250–2020 would affect the calculation of AWEF. The defrost challenge tests and calculations are discussed in detail in sections III.G.8.a, and III.G.8.b of this document.

d. Additional Amendments

In addition to those changes enumerated in sections III.B.3.a through III.B.3.c of this document, AHRI 1250–2020 includes additional amendments that are inconsistent with the current DOE test procedure and would not be expected to impact calculated AWEF. This section discusses those changes.

AHRI 1250–2020 added exclusions for liquid-cooled condensing systems in section 2.2.4. and excludes systems that use carbon dioxide, glycol, or ammonia as refrigerants in section 2.2.5. The current DOE test procedure is neutral with respect to refrigerant, and DOE considers all walk-in refrigeration systems to be covered equipment regardless of the refrigerant used. However, DOE recognizes that modifications may be necessary to the test method for different refrigerants (for example, see discussion in section III.F.6 for CO_2).

As discussed in section III.B.3.a, AHRI 1250–2020 updated many of the tolerances in Table 2 of section 4. Some of these updates are not included in the current CFR language. DOE proposes to adopt the tolerances in AHRI 1250–2020, Table 2 of section 4 in subpart R, appendix C. As discussed later, DOE expects that the updated tolerance values would improve the repeatability of the test procedure with no impact on test cost.

AHRI 1250–2020 includes an updated list of references and the applicable versions of certain test standards in appendix A, ''References—Normative.'' DOE proposes to reference AHRI 1250–2020 appendix A in subpart R, appendix C. DOE expects that this modification would have no impact on test cost, while ensuring that more recent test standards are referenced.

Both AHRI 1250–2009 appendix C and AHRI 1250–2020 appendix C provide specific test methods for testing walk-in cooler and freezer systems, whereas the body of the standard specifies test requirements and calculations for walk-in box load and for determining AWEF. Additionally, AHRI 1250–2020 includes the following updated provisions: Section C3 of AHRI 1250–2009 lists requirements for measuring temperature (Section C3.1), measuring pressure (Section C3.2), measuring refrigerant properties (Section C3.3), determining refrigerant flow (Section C3.4), determining unit cooler fan power (Section C3.5), and specifies measurement and recording intervals (Section C3.6). In AHRI 1250–2020, Section C3 has been expanded to include requirements for measuring off-cycle power (Section C3.5) and determining steady state refrigeration capacity and energy consumption (Section C3.6), which are applicable to all tests unless otherwise specified. Aside from single-packaged dedicated system tests and the off-cycle power tests discussed in the previous section and in Sections III.G.2 and III.G.1, respectively, of this document, DOE does not expect that the revisions made to Section C3 in AHRI 1250–2020 would impact test duration and is therefore proposing to incorporate these sections (except for Section C3.5) [18] into subpart R, appendix C.

Sections C3.1.3.1, C3.1.3.2, and C3.1.3.3 of AHRI 1250–2020 specified refrigerant temperature measurement locations for unit coolers tested alone, matched pairs, and dedicated condensing systems tested alone. Specific changes include:

- For unit coolers tested alone: Refrigerant entering temperature is measured within six pipe diameters upstream of the control device (Section C3.1.3.1).
- For matched pairs, but not single-packaged dedicated systems: Refrigerant entering temperature is measured within the first six inches of the refrigerant pipe entering the unit cooler conditioned space, and the leaving temperature is measured within the last six inches of the refrigerant pipe leaving the unit cooler conditioned space (Section C3.1.3.2); and
- For dedicated condensing units tested alone: Entering and leaving refrigerant temperatures are measured at the inlet and outlet of the unit using two independent measuring systems (Section C3.1.3.3).

The modifications for measuring refrigerant temperature in AHRI 1250–2020 are expected to improve the repeatability and reproducibility of the test procedure, but do not impact test setup or test duration; therefore, DOE is proposing to reference these sections in subpart R, appendix C.

AHRI 1250–2020 added Section C7.5.1.1 to provide more detailed instructions for calculating system capacity beginning with measured temperatures instead of calculated enthalpies, which is what was done in AHRI 1250–2009. Section C7.5.1 also includes the determination of enthalpy from capacity test results.

AHRI 1250–2020 added Section C9.2, which specifies an allowable heat balance of ± 6 percent for single-packaged refrigeration capacity testing. AHRI 1250–2009 required a heat balance of ± 5 percent for all systems. This change was made to align with ASHRAE 37, which AHRI 1250–2020 incorporates by reference for single-packaged testing.

AHRI 1250–2009 included Section C12 ''Method of Testing Condensing Units for Walk-In Cooler and Freezer Systems for Use in Mix-Match System Ratings,'' which referenced AHRAE 23.1–2010. AHRI 1250–2020 now provides specific test methods for testing dedicated condensing units

[17] The defrost challenge tests included in AHRI 1250–2020 are informative test methods that provide validation that defrost is occurring as would be expected in Appendix E for adaptive defrost control systems and in Appendix F for hot gas defrost systems. Neither challenge test is designed to quantify the energy use of the defrost system, but are intended to validate defrost system functionality.

[18] DOE is proposing to incorporate Section C3.5 of AHRI 1250–2020 appendix C as a part of the new appendix C1.

tested alone. DOE has tentatively determined that the test procedure incorporated into AHRI 1250–2020 is the same as that in ASHRAE 23.1–2010 and therefore does not impact test setup or burden. As a result, DOE proposes to no longer incorporate ASHRAE 23.1–2010 by reference.

Section C13 of AHRI 1250–2009, ''Method of Testing Unit Coolers for Walk-In Cooler and Freezer Systems for Use in Mix-Match System Ratings,'' referenced AHRI 420–2008. AHRI 1250–2020 no longer references AHRI 420–2008 and instead outlines a method for unit coolers tested alone. As a result, DOE proposes to no longer incorporate AHRI 420–2008 by reference. DOE has tentatively determined that the test procedure incorporated into AHRI 1250–2020 is the same as that in ASHRAE AHRI 420–2008 and therefore does not impact test setup or burden. As a result, DOE proposes to no longer incorporate AHRI 420–2008 by reference.

C. Proposed Amendments to the Test Procedure in Appendix A for Measuring the Energy Consumption of Walk-in Doors

Appendix A provides the test procedures to measure the energy consumption of the components of envelopes of walk-ins. Specifically, appendix A provides the test procedures to determine the U-factor, conduction load, and energy use of walk-in display panels and to determine the energy use of walk-in display doors and non-display doors. DOE notes that display panels are also subject to the energy consumption test procedure in appendix A. Display panels are discussed in section III.D of this document.

In this NOPR, DOE is proposing to make the following revisions to appendix A, specific to display doors and non-display doors: (1) Reference NFRC 102–2020 in place of NFRC 100 and adopt AEDM provisions; (2) provide further detail on and distinguish the area to be used for determining compliance with standards and the area used to calculate a thermal load from U-factor; (3) establish a percent time off value specific to door motors; and (4) reorganize the test method so that it is easier to follow. The organizational changes include moving the test methods and measurement provisions for determining U-factor up before the provisions for calculating energy consumption and moving the percent time off values for all electrical components into a table. DOE has preliminarily determined that these changes would improve test representativeness and repeatability.

DOE does not expect that the changes it is proposing in this section would have a substantive impact on energy consumption calculations for display doors or non-display doors, except in the case of testing doors with motors as described in the following paragraphs.

The following sections describe the modifications that DOE is proposing to appendix A with respect to walk-in display doors and walk-in non-display doors.

1. Procedure for Determining Thermal Transmittance (U-Factor)

a. Reference to NFRC 102 in Place of NFRC 100

As discussed in section III.B.1 of this document, section 5.3 of appendix A requires manufacturers to determine thermal transmittance, or ''U-factor,'' according to NFRC 100. As also mentioned previously, NFRC 100 includes a computational method for determining U-factor, which involves simulating the U-factor using LBNL's WINDOW and THERM software. Section 4.1.1 of NFRC 100 provides validation requirements so that simulation, rather than a physical test, can be used for rating U-factor for a product line. This approach may be less costly but can result in a different, and potentially less accurate, thermal transmittance value than the thermal transmittance value determined by physical test using NFRC 102. NFRC 100 defines a ''product line'' as a series of individual products of the same product type, and a ''product type'' as a designation used to differentiate between fenestration products based on fixed and operable sash and frame members. Section 4.2.1 of NFRC 100 lists the allowable changes from product to product within a product line. DOE notes that ''product line'' is not synonymous with ''basic model'' as defined in 10 CFR 431.302. DOE understands that simulated U-factors of non-display doors using NFRC 100 have generally not been accurately determined when compared to a physical test.

In the June 2021 RFI, DOE noted it was considering incorporating by reference NFRC 102 as the test method for determining U-factor of walk-in doors in place of NFRC 100 and adopting AEDM provisions for walk-in doors to replace the computational methodology in NFRC 100. 86 FR 32332, 32336. As part of the June 2021 RFI, DOE requested comment on the accuracy of the computational method in NFRC 100 to predict U-factor for display and non-display doors, the magnitude of the difference in U-factor determined using the computational method and using the physical test method, and whether the computational method could be modified to more closely match the results obtained from physical testing. DOE also sought comment on whether manufacturers are using the computational method in NFRC 100 to rate U-factors, whether there are other alternative methods for computationally determining U-factor, and the costs associated with NFRC 100 or other computational methods compared to physical testing. 86 FR 32332, 32336.

NFRC stated that the NFRC 100 computational method has been used to accurately simulate U-factors for display doors because the physical characteristics of a display door are similar to the windows and glass doors for which the NFRC 100 computational method was developed. NFRC also stated, however, that there has been limited success validating NFRC 100 simulations with physical tests for non-display doors because non-display doors, unlike windows and glass doors, have high amounts of insulation and significant thermal bypasses along the door perimeter. (NFRC, No. 10 at p. 1) Similarly, AHRI commented that while NFRC 100 is appropriate and accurate for display doors, it was not designed for non-display doors, but it is not aware of an industry test method better suited for non-display doors. (AHRI, No. 11 at p. 4) NFRC stated that while refinements to the computational method in NFRC 100 may be possible for more accurately determining U-factor of non-display doors, they have not yet been addressed due to limited usage of this method for specimens like non-display doors. NFRC also stated that the computational method does not always result in higher or more conservative U-factors than the U-factors determined through physical test, and that the test and simulation agreement vary in either direction. (NFRC, No. 10 at p. 1)

Anthony and Hussmann stated that in their experience, the U-factors generated using the computational method in NFRC 100 generally align with the U-factors obtained from the physical test method, NFRC 102. (Anthony, No. 8 at p. 2; Hussmann, No. 18 at p. 5) Imperial Brown stated that it is possible to simulate U-factor of non-display doors if the door frame is included in the simulation and provided example simulation cross-sections. (Imperial Brown, No. 15 at p. 2)

The CA IOUs recommended that the physical test method ASTM C1199 be used for doors and window assemblies to provide a measured approach that can be compared to the current calculated method. (CA IOUs, No. 14 at p. 5) Hussmann recommended using the computational method exclusively, except for the physical testing of one model per product line required for validation, stating that physical testing imposes an unnecessary burden on a manufacturer. (Hussmann, No. 18 at p. 5) Imperial Brown asserted that NFRC 102 is costly and time consuming to conduct, and that it is unrealistic to test all of the models they offer since the walk-in door market is highly customizable. Imperial Brown supported continuing to use NFRC 100 and recommended a ''safety factor'' be included to make up for potential inaccuracies of the computational method. (Imperial Brown, No. 15 at pp. 1–2)

Anthony urged DOE to eliminate the requirement for a physical test, stating that there is no added value for it and that physical testing is more than two times the cost of the computational method. Anthony also stated, however, that if NFRC 100 remains the referenced industry test method, the test procedure should specify a course of action if the computational method results fall outside the 10 percent acceptance criteria. (Anthony, No. 8 at p. 2)

NFRC stated that developing an AEDM would be inefficient as the computational method described in NFRC 100 has been shown to be accurate. (NFRC, No. 10 at p. 1) Additionally, NFRC estimated a cost of $2,000 for simulating U-factors for a typical product line of display doors (about 35–50 U-factor values). NFRC emphasized that there is no economy of scale in performing more physical tests because each sample must be tested on its own and requires its own specific setup and time to run. NFRC suggested that given the U-factors of non-display doors cannot typically be simulated within the agreement specified by NFRC 100, the most economical way to determine U-factor for a product line would be to pick a few sizes within the range of offerings and use the worst-case U-factors to represent a range of sizes. (*Id.* At p. 2)

In response to comments received on the accuracy of the computational method, DOE understands that there has been limited success in accurately simulating the U-factor of non-display doors using NFRC 100. Although stakeholders asserted that NFRC 100 can accurately simulate display door U-factors, the recommendation by one stakeholder that instruction be provided when the simulated value and tested value do not agree within the limits specified by NFRC 100 suggests there may be instances when the computational method does not provide sufficiently accurate results. DOE recognizes that if display or non-display door manufacturers are unable to simulate U-factor using NFRC 100, they are currently required to physically test every door basic model, which may be unduly burdensome given the highly customizable nature of the market and thus high number of basic models to test.

In this NOPR, DOE is proposing to remove reference to NFRC 100 from its test procedure and instead reference NFRC 102 and adopt provisions allowing manufacturers to use an AEDM. DOE emphasizes that allowing use of an AEDM would provide manufacturers with the flexibility to use an alternative method that yields the best agreement with a physical test for their doors. If manufacturers have had success using the computational method in NFRC 100, inclusion of AEDM provisions would enable manufacturers to continue using NFRC 100, provided that manufacturers meet the proposed AEDM requirements in 10 CFR 429.53 and 10 CFR 429.70(f). Particularly, under the proposals, manufacturers would need to ensure that the output result of energy consumption from the AEDM is within the proposed 5 percent tolerance of an energy consumption result that includes a physical U-factor test. The proposed adoption of an AEDM is discussed in more detail in section III.H.1.

b. Exceptions to Industry Test Method for Determining U-Factor

Section 5.3 of appendix A references NFRC 100 for determining U-factor with the specific modifications to the industry standard listed in section 5.3(a). The first modification specifies that the average surface heat transfer coefficients during a test must be within ± 5 percent of the values specified through NFRC 100 in ASTM C1199. The second and third items modify the cold and warm side conditions from the standard conditions prescribed in NFRC 100. The final provision listed specifies the direct solar irradiance [19] be 0 Btu/(h-ft^2).

As discussed in the June 2021 RFI, DOE has found that obtaining the standardized heat transfer values within the tolerances specified in section 5.3(a)(1) of appendix A on the warm-side and cold-side may not be achievable depending on the thermal transmittance through the door. 86 FR 32332, 32340. Specifically, the warm-side heat transfer is dominated by natural convection and radiation and the heat transfer coefficient varies as a function of surface temperature. When testing doors with higher thermal resistance, less heat is transferred across the door from the warm-side to the cold-side, so the warm-side surface temperature is closer to the warm-side air temperature.

Sections 6.2.3 and 6.2.4 of ASTM C1199 specify the standardized heat transfer coefficients and their tolerances as part of the procedure to set the surface heat transfer conditions of the test facility using the Calibration Transfer Standard (''CTS'') test. The warm-side surface heat transfer coefficient must be within ± 5 percent of the standardized warm-side value of 1.36 Btu/(h-ft^2-°F), and the cold-side surface heat transfer coefficient must be within ± 10 percent of the standardized cold-side value of 5.3 Btu/(h-ft^2-°F) during the CTS test (ASTM C1199, Sections 6.2.3 and 6.2.4). ASTM C1199 does not require that the measured surface heat transfer coefficients match or be within a certain tolerance of standardized values during the official sample test—although test facility operational (*e.g.,* cold side fan settings) conditions would remain identical to those set during the CTS test. ASTM C1199 also does not require measurement of the warm-side surface temperature of the door. Rather, this value is calculated based on the radiative and convective heat flows from the test specimen's surface to the surroundings, which are driven by values determined from the calibration of the hot box using the CTS test (*e.g.,* the convection coefficient). *See* ASTM C1199, Section 9.2.1. When testing doors with extremely high- or low-thermal resistance, the resulting change in warm-side surface temperature can shift the warm-side heat transfer coefficient out of the tolerance specified in the DOE test procedure. To ensure that these coefficients are within tolerance during the test would require recalibration of the hot box for each specific door.

As part of the June 2021 RFI, DOE requested feedback on the tolerances currently specified in section 5.3(a)(1) of appendix A applied to the surface heat transfer coefficients used to measure thermal transmittance and whether they should be increased or omitted. 86 FR 32332, 32340.

In response, NFRC asserted that applying the surface heat transfer coefficient tolerances to the surface heat

[19] Solar irradiance is the power per unit area received from the sun in the form of electromagnetic radiation.

transfer coefficients determined in the actual U-factor test is not a correct application of the NFRC 102 test method and recommended that the tolerances be removed from section 5.3(a)(1) of appendix A. NFRC additionally stated that the idea behind the CTS calibration tests is to set up a consistent set of fan speeds on both sides of the chamber or to create consistent cold and warm side environments for testing of all products. NFRC further stated that the convection currents will be influenced during sample testing by the surface temperatures of the test sample and that this is an expected and natural occurrence. (NFRC, No. 10 at pp. 3–4)

Given DOE's experience with testing walk-in doors and the comments provided by NFRC, DOE is proposing to remove the requirement listed in section 5.3(a)(1) regarding the surface heat transfer coefficients and the tolerances on them during testing.

Additionally, while DOE did not request specific comment on the surface heat transfer coefficients themselves (*i.e.,* the warm side value of 1.36 Btu/(h-ft^2-°F) and cold side value of 5.3 Btu/(h-ft^2-°F)), Anthony commented that the heat transfer coefficient applied to the cold side of the test specimen correlates to a wind speed roughly equivalent to 12.3 miles per hour (''mph''). Anthony stated that their field testing has demonstrated that the wind speed interior to the walk-in is below 5 mph. (Anthony, No. 8 at pp. 3–4)

DOE is not proposing to deviate from the surface heat transfer coefficients specified in NFRC 102–2020 for calibration because additional investigation is needed. Deviating from these surface heat transfer coefficients would require test labs to change their test chamber calibration procedures and would require manufacturers to retest and re-rate all envelope components subject to the energy consumption test procedure in appendix A. DOE may consider changes to the surface heat transfer coefficients specified in NFRC 102–2020 for calibration in the future if more data became available regarding the internal and external conditions of walk-ins in various installations. At this time however, more data and Departmental analysis would need to be conducted to support any changes to the surface heat transfer coefficients specified in NFRC 102–2020.

DOE also received comment on the direct solar irradiance requirement. NFRC stated that direct solar irradiance of 0 Btu/(h-ft^2) listed in section 5.3(a)(4) of appendix A is not an exception to NFRC 100 and should be removed from appendix A. (NFRC, No. 10 at p. 4) Consistent with DOE's proposal to remove reference to NFRC 100, DOE proposes to remove this requirement in section 5.3(a)(4) of appendix A.

c. Calibration of Hot Box for Measuring U-Factor

As stated previously, NFRC 100 references NFRC 102 as the physical test method for measuring U-factor, which in turn incorporates by reference ASTM C1199. ASTM C1199 references ASTM C1363–05, ''Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus'' (''ASTM C1363''). Section 6.1 of ASTM C1199 and Annexes 5 and 6 of ASTM C1363 include calibration requirements to characterize metering box wall loss and surround panel flanking loss, but the frequency at which these calibrations should occur is not specified in these test standards. As part of the June 2021 RFI, DOE sought comment on the frequency at which test laboratories perform each of the calibration procedures referenced in ASTM C1199 and ASTM C1363, *e.g.,* those used to determine the calibration coefficients for calculating metering box wall loss and surround panel flanking loss. 86 FR 32332, 32340. DOE also requested comment on the magnitude of variation in the calibration coefficients measured during successive calibrations. *Id.*

NFRC stated that because the referenced ASTM standards (*i.e.,* ASTM C1199 and ASTM C1363) do not specify frequency of calibration, NFRC 102 includes calibration frequency requirements in section 6.1. NFRC stated that section 6.1 requires that metering box wall loss and surround panel flanking loss be determined once and verified annually as these values would not inherently change over time. It noted that the verification of the metering box wall loss and surround panel flanking loss requires results to be within 2 Watts of previous characterization results. NFRC added that their experience shows that these results repeat well over time and that an increase in calibration frequency is unnecessary. (NFRC, No. 10 at p. 3)

As NFRC stated, the most recent version of NFRC 102, NFRC 102–2020, includes calibration frequencies and requirements in section 6.1(A). The currently referenced version of NFRC 102, NFRC 102–2010, does not include these calibration requirements. For this reason and because of the comments provided by NFRC, DOE is proposing to adopt the calibration requirements in Section 6.1(A) of NFRC 102–2020.

2. Additional Definitions

a. Surface Area for Determining Compliance With Standards

The surface area of display doors and non-display doors (designated as A_{dd} and A_{nd}, respectively) are used to determine maximum energy consumption (''MEC'') in kWh/day of a walk-in door. 10 CFR 431.306(c)–(d). Surface area is currently defined in section 3.4 of appendix A as ''the area of the surface of the walk-in component that would be external to the walk-in cooler or walk-in freezer as appropriate.'' As currently written, the definition does not provide further detail on how to determine the boundaries of the walk-in door from which height and width are determined to calculate surface area. Additionally, the definition does not specify if these measurements are to be strictly in-plane with the surface of the wall or panel that the walk-in door would be affixed to, or if troughs and other design features on the exterior surface of the walk-in door should be included in the measured surface area. Inconsistent determination of surface area, specifically with respect to the measurement boundaries, may result in unrepresentative and inconsistent MEC values. Additionally, walk-in doors with antisweat heaters are subject to prescriptive standards for power use of antisweat heaters per square foot of door opening. 10 CFR 431.306(b)(3)–(4). DOE considers the area of the ''door opening'' to be consistent with the surface area used to determine MEC.

Display doors are fundamentally different from non-display doors in terms of their overall construction. For example, display door assemblies contain a larger frame that can encompass multiple door openings or leaves, and the entire assembly fits into an opening within a walk-in wall. Non-display doors differ in that they often are affixed to a panel-like structure that more closely resembles a walk-in wall rather than a traditional door frame.

In the June 2021 RFI, DOE described how it applies the current test procedure definition for surface area when determining compliance with standards. 86 FR 32332, 32337. As part of the June 2021 RFI, DOE requested comment on how manufacturers determine surface area for the purpose of evaluating compliance with the MEC performance standards and with the prescriptive standards pertaining to antisweat heaters for both display and non-display doors. *Id.*

AHRI and Hussmann stated that they determine surface area consistent with DOE, and that they do not see any distinctions between display doors and non-display doors that warrant determining surface area differently. (AHRI, No. 11 at p. 7; Hussmann, No. 18 at p. 9) Anthony stated that they include the frame and frame flange as part of the door assembly when determining door surface area. Anthony also stated that, contrary to how they determine surface area, Figure 4–2 of NFRC 100–2017 excludes frame flanges. (Anthony, No. 8 at pp. 2–3) Imperial Brown stated that the area for non-display doors, A_{nd}, should be the clear opening area, or WIC by HIC, which excludes the door frame portion of the door assembly. They also stated that the clear opening area may be smaller than the swinging or sliding portion of the door, which typically overlaps a portion of the door frame. (Imperial Brown, No. 15 at p. 2)

With regard to the prescriptive anti-sweat heater standards, Anthony agreed that the power use of anti-sweat heat per square foot is consistent with the surface area used to determine MEC. (Anthony, No. 8 at pp. 2–3) AHRI and Hussmann stated that they do not see a need to change requirements for the prescriptive standards pertaining to anti-sweat heaters. (AHRI, No. 11 at p. 7; Hussmann, No. 18 at p. 9)

In response to comments received, DOE notes that the description of surface area for determining MEC in the June 2021 RFI considers the structural differences between display and non-display doors and assumes different bounds for determining the surface area of display doors and non-display doors. As described previously, DOE includes the frame in the surface area calculation for display doors, whereas the panel-like frame of non-display doors has not been included in the surface area calculation. However, DOE has observed that many electrical components of non-display doors are sited on or within the frame to which the door is attached. If the non-display door frame is not considered as part of the non-display door, the frame would fall under the category of a walk-in panel. However, the current test procedure for panels does not account for electrical energy consumption. Many of the electrical components sited on the non-display door frame serve a function for operation of the door itself. For example, to keep non-display doors from freezing shut, anti-sweat heaters are used to prevent condensation from accumulating around the edge of the door.

Comments received regarding surface area determination suggest that the approach provided in appendix A may result in inconsistent interpretations as to how to determine this measurement. To clarify this issue, DOE is proposing additional specification on how the surface area is measured. DOE is proposing that the surface area bounds of both display doors and non-display doors be the outer edge of the frame. Specifically, DOE proposes to revise the term ''surface area'' to ''door surface area,'' and to define the new term as meaning the product of the height and width of a walk-in door measured external to the walk-in. Under this definition, the height and width dimensions would be perpendicular to each other and parallel to the wall or panel of the walk-in to which the door is affixed, the height and width measurements would extend to the edge of the frame and frame flange (as applicable) to which the door is affixed, and the surface area of a display door and non-display door would be represented as A_{dd} and A_{nd}, respectively. In addition, DOE proposes to move the defined term from the test procedure in appendix A because, as revised and in light of the following proposal in section III.C.2.b, this term does not apply to the proposed test procedure and is only relevant for determining compliance with the standards. Instead, DOE proposes to include the amended term and revised definition with the other definitions that are broadly applicable to subpart R in 10 CFR 431.302.

b. Surface Area for Determining U-Factor

As stated previously, appendix A currently references NFRC 100, which in turn references NFRC 102 for the determination of U-factor through a physical test. When conducting a simulation, the U-factor is calculated using the projected fenestration product area (A_{pt}), or the area of the rough opening in the wall or roof, for the fenestration product, less installation clearances. *See* NFRC 100, section 3. When conducting physical testing, the U-factor (U_s) is calculated using projected surface area (A_s) and is then converted to the final standardized U-factor (U_{ST}). *See* ASTM C1199, sections 8.1.3 and 9.2.7 as referenced through NFRC 102. Projected surface area (A_s) is defined as ''the projected area of test specimen (same as test specimen aperture in surround panel).'' *See* ASTM C1199, section 3.3 as referenced through NFRC 102.

Currently, equations 4–19 and 4–28 of appendix A specify that surface area of display doors (A_{dd}) and non-display doors (A_{nd}), respectively, are used to convert a door's U-factor into a conduction load. This conduction load represents the amount of heat that is transferred from the exterior to the interior of the walk-in.

As discussed in section III.C.2.a, DOE is proposing to amend the definitions of A_{nd} and A_{dd} to be specific to the exterior plane of the door, including the frame and frame flange as appropriate. Defining the area in this manner is inconsistent with the area (*As*) used to calculate U-factor in NFRC 102–2020.

As part of the June 2021 RFI, DOE sought comment on this inconsistency and feedback on specifying additional detail for the surface area used to determine thermal conduction through a walk-in door to differentiate it from the surface area used to determine the maximum energy consumption of a walk-in door. 86 FR 32332, 32337.

NFRC stated that the area used to convert U-factor into energy use and the area used to determine U-factor must be consistent when calculating conduction load from thermal transmittance. (NFRC, No. 10 at pp. 2–3) NFRC also observed that NFRC 100, NFRC 102, ASTM C1199 and ASTM C1363 all define the area for U-factor based ''n ''projec''ed'' specimen ''r ''open''ng'' area in the wall through which the door is installed. *Id.* NFRC further asserted that since the surface area as defined by A_{dd} and A_{nd} are different from the projected area, heat flow is miscalculated when the tested U-factor is inserted into equations 4–19 and 4–28. *Id.* AHRI and Hussmann declared that they determine surface area in a manner consistent with the DOE regulations in 10 CFR parts 429 and 431 and that they do not see a distinction that warrants determining surface area differently in these instances. (AHRI, No. 11 at p. 7; Hussmann, No. 18 at p. 9)

Imperial Brown stated that for a non-display door, the outer frame is equivalent to a walk-in panel and therefore the frame would have a limited impact on the U-factor calculation of the swinging or sliding portion of the door. (Imperial Brown, No. 15 at p. 2) Imperial Brown separately defined the two types of non-display doors they manufacture, defining a ''panel frame'' as a frame that is connected in-line with other walk-in panels and a ''flat frame'' as a frame that is typically used in retrofit applications or by door-only manufacturers which are non-insulating and mount over and are fastened to walk-in panels. (*Id.* at p. 1) Imperial Brown suggested that manufacturers not be required to separately test basic models for U-factor which differ in their frame type because they believe ''panel'' frames and ''flat'' frames to be equivalent in performance once mounted. Imperial Brown recommended that the same U-factor determined for a door with a ''panel frame'' be used for an otherwise the same door with a ''flat frame.'' (*Id.* at p. 2)

Based on this feedback, DOE has preliminarily determined that using the same area that is used to determine U-factor (A_s in NFRC 102 and ASTM C1199 as referenced) to convert U-factor into a conduction load, rather than the proposed revised term for door surface area in section III.C.2.a (A_{dd} or A_{nd}) results in a more representative conduction load and provides for improved consistency in application of the test procedure across all walk-in doors. As such, DOE proposes to specify that the projected area of the test specimen, A_s, as defined in ASTM C1199, or the area used to determine U-factor is the area used for converting the tested U-factor, U_{ST}, into a conduction load in appendix A. DOE recognizes that this may not change ratings for some doors, where A_s is equivalent to A_{nd} or A_{dd}, but it may result in slightly lower ratings of energy consumption for other doors, where A_s is less than A_{nd} or A_{dd}. DOE expects that since this proposed detail would either result in a reduced energy consumption or have no impact, there would be no need for manufacturers to retest or re-rate. Additional details on how this proposed detail impacts retesting and re-rating are further discussed in section III.J.1.

In response to Imperial Brown's assertion that the frame has a limited impact on the thermal performance of the door, DOE testing of non-display doors found that inclusion of the frame in the U-factor test (which resulted in a 34 to 52 percent increase in total door area) increased the heat transferred through the door assembly by 23 to 139 percent compared to heat transfer through the door leaf alone. This implies that including the frame in the U-factor test does have a measurable impact on the thermal performance of the door assembly. Therefore, DOE also proposes to specify in appendix A that the U-factor test includes the frame of the door to improve consistency in application of the test procedure across all walk-in doors.

3. Electrical Door Components

Sections 4.4.2 and 4.5.2 of appendix A include provisions for calculating the direct energy consumption of electrical components of display doors and non-display doors, respectively. For example, electrical components associated with doors could include, but are not limited to: Heater wire (for anti-sweat or anti-freeze application); lights (including display door lighting systems); control system units; and sensors. *See* appendix A, sections 4.4.2 and 4.5.2. For each electricity-consuming component, the calculation of energy consumption is based on the component's ''rated power'' rather than a measurement of its power draw. Section 3.5 of appendix A defines ''rated power'' as the electricity consuming device's power as specified (1) on the device's nameplate or (2) from the device's product data sheet if the device does not have a nameplate or such nameplate does not list the device's power.

DOE has observed that walk-in doors often provide a single nameplate for the door, rather than providing individual nameplates for each electricity-consuming device. In many cases, the nameplate does not provide separate power information for the different electrical components. Also, the nameplate often specifies voltage and amperage (a measure of current) ratings without providing wattage (a measure of power) ratings, as is referenced by the definition of ''rated power.'' While the wattage is equal to voltage multiplied by the current for many components, this may not be true for all components that may be part of a walk-in door assembly. Furthermore, nameplate labels typically do not specify whether any listed values of rated power or amperage represent the maximum operation conditions or continuous steady state operating conditions, which could differ for components such as motors that experience an initial surge in power before power use levels off. These issues make calculating a door's total energy consumption a challenge for a test facility that does not have in-depth knowledge of the electrical characteristics of the door components.

As part of the June 2021 RFI, DOE requested comment on whether, and if so how, an option for direct component power measurement could be included in the test procedure or DOE's CCE provisions to allow for a more accurate accounting of the direct electrical energy consumption of WICF doors. 86 FR 32332, 32338.

ASAP supported adding an option for direct measurement of power consumed by door electrical components. (ASAP, No. 13 at p. 1) The CA IOUs also supported direct measurement of power used by door components, but more specifically for components designed to operate at partial nameplate power such as door motors or powered door closers. The CA IOUs stated that, in their experience, power measurement for resistance components like lighting and door heaters are not necessary if these components are designed to operate at full nameplate power. They recommended that the electrical energy consumption of door motors be reported per door opening and that the electrical energy consumption be calculated as the actual power consumption of the motor multiplied by the duration of the door opening and closing. (CA IOUs, No. 14 at p. 4) Hussmann and Imperial Brown supported maintaining the current approach of using rated power for calculating direct electrical energy consumption and did not see a need for the measurement option. (Hussmann, No. 18 at p. 10; Imperial Brown, No. 15 at pp. 2–3) Imperial Brown also stated that control components are typically rated at 5 Watts or less and that they should be excluded from the calculation of direct electrical energy consumption. (Imperial Brown, No. 15 at pp. 2–3)

DOE is not proposing to include provisions requiring measurement of power consumption of electrical door components in the test procedure in appendix A because additional investigation is needed. However, DOE has observed that some manufacturers may be certifying door motor power as the output power rating of the motor, rather than the input power of the motor. Thus, DOE is proposing to specify in appendix A that the rated power of each electrical component, $P_{rated,u,t}$, would be the rated input power of each component because the input power represents power consumption.

Additionally, DOE has observed through testing that the measured power of some walk-in door electrical components exceeds either the certified or nameplate power values of these electrical components. For the purposes of enforcement testing, DOE is proposing in 10 CFR 429.134(q) that DOE may validate the certified or nameplate power values of an electrical component by measuring the power when the device is energized using a power supply that provides power within the allowable voltage range listed on the nameplate. If the measured input power is more than 10 percent higher than the power listed on the nameplate or the rated input power in a manufacturer's certification, then the measured input power would be used in the energy consumption calculation. For electrical components with controls, the maximum input wattage observed while energizing the device and activating the control would be considered the measured input power.

4. Percent Time Off Values

The test procedure also assigns percent time off (''PTO'') values to various walk-in door components. PTO values are applied to reflect the hours in a day that an electricity-consuming device operates at its full-rated or certified power (*i.e.,* daily component energy use is calculated assuming that the component operates at its rated power for a number of hours equal to 24 multiplied by − 1 - PTO)). PTO values are not incorporated in the rated or certified power of an electricity-consuming device. Table III.3 lists the PTO values in the current DOE test procedure for walk-in doors.

TABLE III.3—ASSIGNED PTO VALUES FOR WALK-IN DOOR COMPONENTS

Component type	Percent time off (PTO) (%)
Lights without timers, control system or other demand-based control	25
Lights with timers, control system or other demand-based control	50
Anti-sweat heaters without timers, control system or other demand-based control	0
Anti-sweat heaters on walk-in cooler doors with timers, control system or other demand-based control	75
Anti-sweat heaters on walk-in freezer doors with timers, control system or other demand-based control	50
All other electricity consuming devices without timers, control systems, or other auto-shut-off systems	0
All other electricity consuming devices for which it can be demonstrated that the device is controlled by a preinstalled timer, control system or other auto- shut-off system	25

As discussed in the June 2021 RFI, DOE has granted waivers to several manufacturers of doors with motorized door openers, allowing for the use of a different PTO for motors. 86 FR 32332, 32338–32339. The manufacturers who requested and were granted waivers and the PTO defined in their alternate test procedure are shown in Table III.4.

TABLE III.4—PTO VALUES GRANTED IN DECISION AND ORDERS FOR MANUFACTURERS OF DOORS WITH MOTORIZED DOOR OPENERS

Manufacturer	Percent time off (PTO) (%)	Decision and order **Federal Register** citation
HH Technologies	96	83 FR 53457. (Oct. 23, 2018).
Jamison Door Company	93.5	83 FR 53460. (Oct. 23, 2018).
Senneca Holdings	97	86 FR 75. (Jan. 4, 2021).
Hercules	92	86 FR 17801. (Apr. 6, 2021).

In the June 2021 RFI, DOE requested comment on the current PTO values for all electricity-consuming devices, whether these values should be amended, and whether specific values should be added for certain electrical components, such as motors. 86 FR 32332, 32339.

In response, Hussmann stated that they determine energy consumption consistent with DOE's regulations in parts 429 and 431 and do not see a need to change the current PTO values. (Hussmann, No. 18 at p. 10) ASAP supported adding specific PTO values for motorized door openers because they believe it will provide similar treatment for these components as for other electrical components and eliminate the need for ongoing test procedure waivers. (ASAP, No. at p. 1) The CA IOUs recommended that DOE reduce the usage factor of door opening motors from 75 percent to 5 percent or less (*i.e.,* implement a PTO of 95 percent or greater). In their comments, the CA IOUs provided anecdotal data for two food service sites where doors were open an average of 20 and 40 minutes per day. The CA IOUs observed that if these doors had motors, the motor on time would be even less than the time recorded in the open position. Additionally, the CA IOUs recommended that DOE explore the differences in opening patterns among passage, freight, and display doors and potentially adjust the door motor PTO based on door opening pattern for each corresponding class. (CA IOUs, No. 14 at pp. 5–6)

As shown in Table III.4, each manufacturer requested a PTO value specific to their door and motor characteristics, resulting in four different PTO values. For this proposal, DOE evaluated a PTO that could be used to consistently evaluate energy consumption of doors with motors and would be sufficiently representative. Recognizing that the PTO values requested in the waivers are relatively close to one another, DOE calculated an average PTO value based on the information received in the waivers and is proposing to specify one PTO value for all basic models of doors with motors to use. This approach results in a more representative test procedure for doors with motors as compared to the current value specified for other electricity-consuming devices in appendix A. The intent of the PTO value is not to reflect behaviorally-related energy consumption of each individual installation of a door with a motor, but to provide a more representative means for comparison of walk-in door performance.

DOE calculated an average PTO value, as follows. For each motorized door offering from manufacturers that were granted waivers, DOE used the cycle rating as specified in the product literature. When a cycle rating was not provided in the product literature, DOE used its previously estimated number of door openings per day of 60 for passage doors and 120 for freight doors, respectively.[20] 75 FR 55068, 55085.

[20] DOE's previously estimated door openings per day were relevant for a proposal to address door opening infiltration in the test procedure introduced in a supplemental notice of proposed rulemaking from September 9, 2010. Ultimately, DOE did not adopt test procedure provisions addressing door opening infiltration, having determined that a typical door manufacturer has very few direct means for reducing the door

Continued

DOE then calculated the PTO range for each motor offering using the cycle rating or DOE's cycle assumption, the maximum opening size offered by the manufacturer, and the minimum and maximum operating speeds of the motor. DOE averaged these PTO ranges across each motor offering and then averaged them across all manufacturers. This yielded an average PTO of 97 percent.

Considering the waivers granted, DOE's own calculations, and comments received, DOE is proposing to adopt a door motor PTO value of 97 percent for display doors with motors and non-display doors with motors.

As discussed in the June 2021 RFI, DOE is aware that some manufacturers design and market walk-in cooler display doors for high humidity applications. Ratings from the CCMS database show these doors have more anti-sweat heater power per door opening area than standard cooler display doors. 86 FR 32332, 32339. Section 4.4.2(a)(2) of appendix A requires a PTO value of 50 percent be used when determining the direct energy consumption for anti-sweat heaters with timers, control systems, or other demand-based controls situated within a walk-in cooler door (which would include walk-in cooler doors marketed for high humidity applications). This approach assumes that the anti-sweat heaters are not operating for 50 percent of the time. DOE recognizes that anti-sweat heaters may be in operation for a different amount of time in high humidity installations than in standard installations. In the June 2021 RFI, DOE requested comment on whether the current PTO of 50 percent is appropriate for evaluating direct energy consumption of anti-sweat heaters with controls for walk-in cooler doors marketed for high humidity applications and the amount of time per day or per year that anti-sweat heaters with controls are off for high humidity doors. *Id.*

In response, DOE received comments from Anthony, AHRI, and Hussmann regarding the maximum energy consumption of high humidity doors. (Anthony, No. 8 at p. 3; AHRI, No. 11 at pp. 7–8; Hussmann, No. 18 at p. 10) However, as the responses of these comments were more focused on the standards, DOE plans to address these comments as part of a separate standards rulemaking for this equipment. DOE did not receive any comments regarding whether the PTO in the test procedure for anti-sweat heaters with controls sited on high humidity doors should be modified nor any data on the amount of time the anti-sweat heaters operate on high-humidity doors as compared to standard doors (*i.e.,* cooler display doors). DOE is not proposing any changes to the PTO values for anti-sweat heaters sited on high humidity doors at this time.

5. EER Values

To calculate the daily energy consumption associated with heat loss through a walk-in door, appendix A requires dividing the calculated heat loss rate by specified energy efficiency ratio (''EER'') values of 12.4 Btu per Watt-hour (''Btu/W-h'') for coolers and 6.3 Btu/(W-h) for freezers. Appendix A, sections 4.4.4(a) and 4.5.4(a). DOE selected EER values of 12.4 Btu/(W-h) for coolers and 6.3 Btu/(W-h) for freezers because these are typical EER values of walk-in cooler and walk-in freezer refrigeration systems, respectively.[21] 75 FR 186, 209 (Jan. 4, 2010); 76 FR 21580, 21593–21594 (Apr. 15, 2011). The DOE test procedure in subpart R, appendix C, also assigns nominal EER values, which correspond to the appropriate adjusted dew point temperature in Table 17 of AHRI 1250–2009,[22] when testing the refrigeration systems of walk-in unit coolers alone. The resulting EER values for unit coolers tested alone are 13.3 Btu/(W-h) for coolers and 6.6 Btu/(W-h) for freezers, which are different than the EER values of 12.4 Btu/(W-h) and 6.3 Btu/(W-h), respectively, applied to walk-in doors, as described previously. In the June 2021 RFI, DOE sought feedback on the EER values specified in appendix A used to calculate daily energy consumption for walk-in doors and the values used to test unit coolers as specified in subpart R, appendix C. Specifically, DOE requested comment on whether the EER values used for door testing and unit cooler testing consistent with each other, and if so, which values are more representative. 86 FR 32332, 32339.

Anthony responded that the EER values referenced in subpart R, appendix C (*i.e.,* 13.3 Btu/(W-h) for coolers and 6.6 Btu/(W-h) for freezers), better reflect current compressor efficiency for walk-in refrigeration systems. (Anthony, No. 8 at p. 3) National Refrigeration encouraged DOE to keep the current EER values, stating that they believe the values are accurate, but did not specify if they were referring to walk-in door or refrigeration system EER values. (National Refrigeration, No. 17 at p. 1) Keeprite, Lennox, and AHRI all supported maintaining the EER values applicable to unit coolers in subpart R, appendix C. (Keeprite, No. 12 at p. 2; Lennox, No. 9 at p. 4; AHRI, No. 11 at p. 8)

Based on the comments received, it is not clear that there is an advantage to harmonizing the EER values between appendix A and subpart R, appendix C. Therefore, DOE is not proposing to change the subpart R, appendix C, EER values pertaining to walk-in refrigeration systems.

Additionally, with respect to envelope components, DOE is not proposing to align the EER values in appendix A for calculating the energy consumption of envelope components with the EER values used for testing unit coolers alone in subpart R, appendix C, at this time. DOE originally defined nominal EER values in appendix A because an envelope component manufacturer generally cannot control what refrigeration equipment is installed, and the defined EER value is intended to provide a nominal means of comparison rather than reflecting an actual walk-in installation. 76 FR 21580, 21593 (Apr. 15, 2011). In other words, the EER values used to estimate energy consumption of the envelope components is a constant. DOE notes that the difference between the EER values used in appendix A for doors and those used in subpart R, appendix C, for unit coolers is seven percent for coolers and five percent for freezers, which would have minimal impact on rated values but would require manufacturers to retest and re-rate energy consumption without necessarily providing a more representative test procedure.

infiltration on its own. 76 FR 21580, 21595 (Apr. 15, 2011).

[21] The difference in EER values between coolers and freezers reflects the relative efficiency of the refrigeration equipment for the associated application. 75 FR 186, 197. As the temperature of the air surrounding the evaporator coil drops (that is, when considering a freezer relative to a cooler), thermodynamics dictates that the system effectiveness at removing heat per unit of electrical input energy decreases. *Id.*

[22] The dewpoint temperature to be used for testing unit coolers alone is defined in section 3.3.1 of appendix C to be the Suction A saturation condition provided in Tables 15 or 16 of appendix C (for refrigerator unit coolers and freezer unit coolers, respectively). Table 15 for refrigerator unit coolers defines the Suction A saturation condition (*i.e.,* dewpoint temperature) as 25 °F. Table 16 for freezer unit coolers defines the Suction A dewpoint temperature as –20 °F. Furthermore, section 7.9.1 of AHRI 1250–2009 specifies that for unit coolers rated at a suction dewpoint other than 19 °F for a coolers and –26 °F for a freezer, the Adjusted Dewpoint Value shall be 2 °F less than the unit cooler rating suction dewpoint—resulting in adjusted dewpoint values of 23 °F and − 22 °F for refrigerator unit coolers and freezer unit coolers, respectively.

6. Air Infiltration Reduction

EPCA includes prescriptive requirements for doors used in walk-in applications which are intended to reduce air infiltration. Specifically, walk-ins must have (A) automatic door closers that firmly close all walk-in doors that have been closed to within 1 inch of full closure (excluding doors wider than 3 feet 9 inches or taller than 7 feet), and (B) strip doors, spring-hinged doors, or other method of minimizing infiltration when doors are open. (42 U.S.C. 6313(f)(1)(A)–(B)) DOE previously proposed methods for determining the thermal energy leakage due to steady state infiltration through the seals of a closed door and door opening infiltration. DOE did not ultimately adopt these methods as part of the test procedure because DOE concluded that steady state infiltration was primarily influenced by on-site assembly practices rather than the performance of individual components. 76 FR 21580, 21594–21595 (April 15, 2011) (''April 2011 final rule''). Similarly, DOE stated that, based on its experience with the door manufacturing industry, door opening infiltration is primarily reduced by incorporating a separate infiltration reduction device at the assembly stage of the complete walk-in. *Id.* In the June 2021 RFI, DOE invited comment on whether it should account for steady state and/or door opening infiltration in its test procedure. 86 FR 32332, 32340–32341. DOE also requested test methods and calculations to quantify heat load, the associated costs of any suggested methods, and supporting data on door usage patterns. *Id.*

ASAP encouraged DOE to incorporate a measurement of air infiltration into the test procedure for walk-in doors because it would improve representativeness and encourage the development and deployment of technologies that could reduce infiltration and save energy. (ASAP, No. 13 at p. 2) The CA IOUs recommended that DOE consider specifically incorporating door opening infiltration energy into the test procedure. They also suggested that DOE validate the actual savings of devices such as air curtains to determine if the test method should be refined to more accurately represent these features in the determination of walk-in performance. (CA IOUs, No. 14 at p. 6) In contrast, Imperial Brown stated that including air infiltration in the test procedure would be burdensome and cost prohibitive because most WICF doors are custom-made. (Imperial Brown, No. 15 at p. 3)

DOE is not proposing to include air infiltration in the test procedure for determining energy consumption of walk-in envelope components at this time because additional investigation is needed. DOE intends to consider data on the magnitude of air infiltration for walk-ins as it becomes available for appropriate evaluation of the representativeness of including it in the test procedure for walk-in doors. However, as previously mentioned, EPCA requires air infiltration limiting devices on all doors. (42 U.S.C. 6313(f)(1)(A)–(B)) Even though air infiltration is not currently evaluated as part of the current test procedure and is thus not part of the performance standard, all walk-in doors are subject to the prescriptive requirements pertaining to air infiltration limiting devices.

D. Proposed Amendments to the Test Procedure in Appendix A for Display Panels

Appendix A specifies the test procedure to determine energy consumption of walk-in display panels, which are not currently subject to any performance standards in terms of daily energy consumption, but are subject to the prescriptive requirements at 10 CFR 431.306.

In the June 2021 RFI, DOE requested specific comment on the current test procedure for determining energy consumption for display panels and whether any amendments to this procedure were warranted. 86 FR 32332, 32342. In response, Anthony and NFRC commented that the test procedure for display panels should be identical to the test procedure for display doors. (Anthony, No. 8 at p. 4; NFRC, No. 10 at p. 4)

DOE is proposing that the changes proposed throughout section III.C for determining conduction load and energy consumption of display doors would also be applicable to determining display panel conduction load and energy consumption, except for the provisions applicable to electrical components and percent time off values.

E. Proposed Amendments to the Test Procedure in Appendix B for Panels and Non-Display Doors

The insulation R-value of walk-in non-display panels and non-display doors is determined using appendix B. In this NOPR, DOE is proposing to modify appendix B to improve test representativeness and repeatability. Specifically, DOE is proposing to make the following revisions to appendix B: (1) Reference the updated industry standard ASTM C518–17; (2) include more detailed provisions on measuring insulation thickness and test sample thickness; (3) provide additional guidance on determining parallelism and flatness of test specimen; and (4) reorganize appendix B so it is easier for stakeholders to follow as a step-by-step test procedure.

DOE does not expect that the changes it is proposing in this section would have a significant impact on measured R-value of insulation. Rather, the revisions proposed for appendix B address repeatability issues that DOE has observed through its testing of the insulation of walk-in panels.

The following sections describe the modifications that DOE is proposing to appendix B, the test procedure for determining the R-value of walk-in envelope component insulation. DOE discusses the proposed changes specifically in the context of walk-in panels; however, DOE notes that non-display doors are also subject to the prescriptive R-value requirement at 10 CFR 431.306(a)(3) and that the R-value for walk-in door insulation is determined using appendix B.

1. Specimen Conditioning

In the June 2021 RFI, DOE noted that the test specimen conditioning instruction and example given in section 7.3 of ASTM C518 conflict with the provision in section 4.5 of the DOE test procedure at appendix B that requires testing per ASTM C518 be completed within 24 hours of specimens being cut for the purpose of testing. 86 FR 32332, 32341–32342. Section 7.3 of ASTM C518 directs that a test specimen be conditioned prior to testing and states that this be done per material specifications. If material specifications for conditioning are not provided, the specimen preparation shall be conducted so as not to expose the specimen to conditions which would change the specimen in an irreversible manner. Section 7.3 of ASTM C518 provides an example of a material specification that requires test specimen conditioning at 72 °F and 50 percent relative humidity until less than a one percent change in mass is observed over a 24-hour period. As part of the June 2021 RFI, DOE sought comment on whether manufacturers of insulation specify conditioning for insulation materials that differ from the typical approach described in ASTM C518. DOE also requested feedback on whether more than one 24-hour conditioning period is ever needed to complete specimen conditioning given ASTM's requirement regarding change in mass. Lastly, DOE requested data on panel performance for conditioning times less than 24 hours, specifically, how conditioning time impacts the accuracy, repeatability, and representativeness of the test. 86 FR 32332, 32342.

Imperial Brown stated that the panel should cure for 30 days before a test specimen is cut and that the test specimen should be tested within 24 hours of being cut. Imperial Brown asserted that conditioning for longer than 24 hours would create an issue with outgassing, particularly on a small test specimen. Additionally, Imperial Brown observed that the 180-day conditioning period specified in ASTM C1029–2015, ''Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation'' would be unrealistic and a significant test burden. (Imperial Brown, No. 15 at p. 3)

In response to the suggestion by Imperial Brown that a panel should cure for 30 days before a test, DOE notes that section 4.5 of the current test procedure in appendix B already specifies that foam insulation be tested after it is produced in its final chemical form. For foam-in-place insulation, this means the foam has cured as intended and is ready for use in a finished panel. In response to the comments received regarding outgassing of the test specimen for conditioning times beyond 24 hours, preliminary tests conducted by DOE demonstrate negligible change in mass of the test specimen within 24 to 48 hours and negligible difference in R-value when compared to a test specimen from the same foam that was tested within 24 hours. Regarding the 180-day conditioning period specified in ASTM C1029–2015, DOE has tentatively concluded that this timeframe for testing is unrealistic and burdensome. Considering all the information at hand, DOE is not proposing any changes to the current requirement that testing be completed with 24 hours of the test specimen being cut from the envelope component. Correspondingly, DOE is not proposing to reference Section 7.3 of ASTM C518–17 regarding specimen conditioning.

2. Total Insulation and Test Specimen Thickness

Section 4.5 of appendix B currently requires that K-factor of a 1 ± 0.1-inch sample of insulation be determined according to ASTM C518–04. The walk-in envelope component insulation R-value is determined by dividing the envelope component insulation thickness by the K-factor. As mentioned in the June 2021 RFI, the measurement of total insulation thickness is important in determining the envelope component's insulation R-value. 86 FR 32332, 32341. As part of the June 2021 RFI, DOE requested comment on how panel thickness is typically measured. *Id.* DOE did not receive any comments in response to this request.

In order to make the test procedure in appendix B more repeatable, DOE is proposing to include instructions for determining both the total insulation thickness as well as the test specimen insulation thickness prior to conducting the test to determine K-factor using ASTM C518–17. DOE is also proposing step-by-step instructions for specimen preparation, including detailed instructions of the number and locations of thickness and area measurements and from where the test specimen should be removed from the overall envelope component. DOE proposes to require the following steps for determining the total thickness of the foam, t_{foam}, from which the final R-value would be calculated:

- The thickness around the perimeter of the envelope component is determined as the average of at least 8 measurements taken around the perimeter, but avoiding the edge region; [23]
- The area of the entire envelope component is calculated as the width by the height of the envelope component;
- A sample is cut from the center of the envelope component relative to the envelope component's width and height. The specimen to be tested using ASTM C518–17 would be cut from the center sample;
- The thickness of the sample cut and removed from the center of the envelope component is determined as the average of at least 8 measurements, with 2 measurements taken in each quadrant;
- The area of the sample cut and removed from the center of the envelope component is determined as the width by the height of the cut sample;
- Any facers on the sample cut from the envelope component shall be removed while minimally disturbing the foam and the thickness of each facer shall be the average of at least 4 measurements;
- The average total thickness of the foam shall then be determined by calculating an area-weighted average thickness of the complete envelope component less the thickness of the facers.

For preparing and determining the thickness of the 1-inch test specimen, DOE proposes to include the following steps:

- A 1 ± 0.1-inch-thick specimen shall be cut from the center of the cut envelope sample removed from the center of the envelope component;
- Prior to testing, the average of at least nine thickness measurements at evenly-spaced intervals around the test specimen shall be the thickness of the test specimen, *L*.

Issue 9: DOE requests feedback on the proposed provisions relating to test specimen and total insulation thickness and test specimen preparation prior to conducting the ASTM C518–17 test.

3. Parallelism and Flatness

The test procedure for determining R-value also requires that the two surfaces of the tested sample that contact the hot plate assemblies (as defined in ASTM C518) maintain ± 0.03 inches flatness tolerance and maintain parallelism with respect to one another within a tolerance of ± 0.03 inches.[24] *See* appendix B, section 4.5. As mentioned in the June 2021 RFI, the current test procedure does not provide direction on how flatness and parallelism should be measured or calculated. 86 FR 32332, 32341. As part of the June 2021 RFI, DOE sought comment on how flatness and parallelism are determined by test laboratories and whether the DOE test procedure should include instruction on how to determine these parameters. *Id.* While DOE received no comments in response to this request for comment, DOE believes that accurate and repeatable determination of a specimen's R-value requires the specimen under test to be both flat and parallel. Therefore, DOE proposes to include the following steps for determining the parallelism and flatness of the tested specimen in appendix B:

- Prior to determining the specimen thickness, the specimen would be placed on a flat surface and gravity will determine the specimen's position on the surface. As specified previously, a minimum of nine thickness measurements would be taken at equidistant positions on the specimen. These measurements would be associated with side 1 of the specimen.
- The least squares plane of side 1 is determined based on the height measurements taken. The theoretical height of the least squares plane is

[23] *Edge region* means a region of the panel that is wide enough to encompass any framing members. If the panel contains framing members (*e.g.,* a wood frame) then the width of the edge region must be as wide as any framing member plus an additional 2 in. ± 0.25 in. *See* section 3.1 of appendix B.

[24] Maintaining a flatness tolerance means that no part of a given surface is more distant than the tolerance from the ''best-fit perfectly flat plane'' representing the surface. Maintaining parallelism tolerance means that the range of distances between the best-fit perfectly flat planes representing the two surfaces is no more than twice the tolerance (*e.g.,* for square surfaces, the distance between the most distant corners of the perfectly flat planes minus the distance between the closest corners is no more than twice the tolerance).

determined at each measurement location in the x and y (length and width) direction of the specimen.

• The difference at each measurement location between actual height measurement and theoretical height measurement based on the least squares plane is calculated. The maximum value minus the minimum value is the flatness associated with this side (side 1). In order for each side of the specimen to be considered flat, this value would need to be less than or equal to 0.03 inches.

• Flip the specimen so that side 1 is now on the flat surface and let gravity determine the specimen position on the surface. Repeat the above steps for side 2 of the specimen.

• To determine if each side of the specimen is parallel, the theoretical height at the four corners (*i.e.,* at points (0,0), (0,12), (12,0), and (12,12)) of the specimen must be calculated using the least squares plane. The difference in the maximum and minimum heights would represent the parallelism of one side and would need to be less than or equal to 0.03 inches for the specimen to be considered parallel.

Issue 10: DOE requests feedback on the proposed provisions relating to determining parallelism and flatness of the test specimen.

4. Insulation Aging

In the April 2011 final rule, DOE adopted a test procedure that referenced two industry test standards [25] that considered aging of insulation for foams that experience aging. 76 FR 21580, 21588–21592. However, after receiving comments concerning test burden and the availability of labs to conduct the test procedure, DOE re-evaluated its earlier decision and removed this portion of the walk-in panel test procedure in the final rule published May 13, 2014 (''May 2014 final rule''). 79 FR 27388, 27405–27406. Although the current test procedure for determining panel R-value does not account for aging, manufacturers have raised concern regarding insulation aging and its potential effect on testing results.

''Aging'' of foam insulation refers to how diffusion of blowing agents out of the foam and diffusion of air into the foam impacts thermal resistance of insulation materials. The gaseous blowing agents contained in the foam provide the foam with much of its insulating performance, represented by the R-value of the foam material. Because air has a lower insulating value than the blowing agents used in foam insulation, the increased ratio of air to blowing agent reduces the foam insulation performance, which reduces the R-value of the foam material. The building industry uses long-term thermal resistance (''LTTR'') to represent the R-value of foam material over its lifetime by describing the insulating performance changes due to diffusion over time. The presence of impermeable facers on a foam structure may delay the rate of aging or reduce the decrease in R-value when compared to a foam structure that is unfaced or has permeable facers. Blowing agents and temperature and humidity conditions may also affect the amount or rate of aging that occurs in a foam structure.

Since the May 2014 final rule, DOE worked with the Oak Ridge National Laboratory (''ORNL'') to conduct a study on performance aging and thermal bridging of walk-in cooler and freezer panels.[26] In this study, multiple panels from five manufacturers were allowed to age intact (*i.e.,* with facers attached) at room temperature, with 1-inch samples taken from the middle of a given panel for testing according to the test procedure in appendix B. These samples were tested upon receipt of the panels and extracted at various times throughout 5 years from intact panels (*i.e.,* with facers attached). Aging panels with their facers attached is representative of how panels are stored and, ultimately, installed for use in a walk-in box. Appendix B does not test with facers because, as previously stated, the DOE test procedure evaluates only the R-value of the foam insulation—not the R-value of the entire panel.

Based on DOE evaluation of product literature, there are two common ways to manufacture walk-in panels: (1) Foaming metal skins in place using closed cell polyurethane foam (''PUF'') or (2) gluing layers of previously-hardened foam to metal skins. DOE research suggests that PUF is the most common insulation used in walk-ins. To manufacture PUF panels, the PUF is injected and hardened using jigs that firmly maintain exterior panel dimensions until the foam has cooled and hardened. This process encourages standardization of panel dimensions as jigs are expensive and typically have limited adjustability. Extruded polystyrene (''XPS'') is used by some manufacturers to construct walk-in panels. XPS-based walk-ins are built in layers of XPS, a previously-hardened foam material that is shipped in sheets to the original equipment manufacturer (''OEM''), where it is cut to the desired shape and assembled. Customization is more common with XPS panels. XPS strongly resists water absorption, preventing panels from losing their insulative properties should water or condensation leaks develop. Other layered panel assembly materials include polyisocyanurate and expanded polystyrene (''EPS'') which are used less but are still offered by some manufacturers. Polyisocyanurate has similar advantages to XPS, but generally has lower thermal resistivity at lower temperature conditions. EPS also has similar advantages to XPS in terms of moisture absorption, but generally has a lower R-value. The study conducted at ORNL evaluated four panel brands manufactured with PUF and one panel brand manufactured using XPS. The R-value of insulation measured by ORNL at the initial test date and most recent test date are summarized in Table III.5.

TABLE III.5—SUMMARY OF R-VALUE TEST RESULTS AT INITIAL TEST DATE AND MOST RECENT TEST DATE FROM ORNL STUDY

Label	Foam type	Temperature condition	Number of years after initial test	R-value
F1	PUF	Freezer	0 (initial test)	31.2
			2.3	30.9
F2	PUF	Freezer	0 (initial test)	31.8
			4.2	30.3

[25] DOE referenced DIN EN 13164:2009–02, ''Thermal insulation products for buildings—Factory made products of extruded polystyrene foam (XPS)—Specification'' and DIN EN 13165:2009–02, ''Thermal insulation products for buildings—Factory made rigid polyurethane foam (PUR) products—Specification.''

[26] A presentation on ORNL's study can be found online at *https://www.osti.gov/biblio/1844325-impact-thermal-bridging-imperfections-aging-effective-value-walk-cooler-freezer-panels.* DOE acknowledges that panels are shipped for assembly in walk-ins with the foam already in final chemical form between facers. Thus, the most applicable evaluation of change in insulation R-value over time is demonstrated by the red data points (labeled ''2'') for the foam that remained intact with the facers on slides 26 through 30 of ORNL's presentation.

TABLE III.5—SUMMARY OF R-VALUE TEST RESULTS AT INITIAL TEST DATE AND MOST RECENT TEST DATE FROM ORNL STUDY—Continued

Label	Foam type	Temperature condition	Number of years after initial test	R-value
C1	PUF	Cooler	0 (initial test)	28.2
			4.8	26.8
C2	XPS	Cooler	0 (initial test)	25.0
			4.7	23.1
C3	PUF	Cooler	0 (initial test)	28.0
			0.5	27.8

Based on ORNL's study, DOE considers the effects of foam insulation aging for walk-in refrigeration panels sold with facers to be minimal when panel facers remain attached to the foam (*i.e.,* when the panel remains intact.). DOE understands that for the purposes of certification and represented R-values, manufacturers are determining their represented R-value by testing specimens from panels at the point of manufacture (*i.e.,* R-value without aging). For assessment and enforcement testing conducted to support the enforcement of DOE's energy conservation standards, DOE is generally able to test samples within one to three months after receipt. The time lag from when the panel is manufactured and when testing is conducted at a lab is typically significantly shorter than that evaluated in the ORNL study; therefore, DOE expects any reduction in R-value to be even less during the period from date of manufacture to assessment or enforcement test date. Additionally, walk-in panels received by DOE for assessment and enforcement testing are evaluated upon arrival to ensure that they are received intact (*i.e.,* with facers) and undamaged and testing of the specimen is completed within 24 hours of sample removal from the panel, as specified in section 4.5 of the DOE test procedure in appendix B. DOE does not expect any reduction in R-value within 24 hours of the sample being cut from the panel.

Issue 11: DOE seeks comment on other comparable data or studies of aging of foam panels that are representative of the foam insulation, blowing agents, and panel construction currently used in the manufacture of walk-in panels. DOE also requests comment on whether manufacturers have been certifying R-value at time of manufacture or after a period of aging.

5. Determining Energy Consumption of Panels That Are Not Display Panels

When DOE initially established the test procedures for components of a WICF in its April 2011 final rule, DOE adopted a test method for measuring the overall thermal transmittance of a walk-in panel, including the impacts of thermal bridges[27] and edge effects (*e.g.,* due to framing materials and fixtures used to mount cam locks). 76 FR 21580, 21605–21612. This method was based on an existing industry test method, incorporating by reference ASTM C1363. *Id.* However, after receiving comments concerning test and cost burden and the lack of availability of labs to conduct the test procedure, DOE re-evaluated its earlier decision and removed this portion of the walk-in panel test procedure in the May 2014 final rule. 79 FR 27388, 27405–27406. As previously stated, the current test procedure in appendix B for non-display panels evaluates insulation R-value according to ASTM C518–04. In the June 2021 RFI, DOE requested information regarding panel construction factors that would affect overall thermal transmission and the magnitude of these effects. 86 FR 32332, 32342. DOE also requested comment on alternative test methods to measure overall thermal transmittance of a panel assembly along with the number of labs that are qualified to run ASTM C1363. *Id.*

ASAP and the CA IOUs encouraged DOE to consider a test method that captures overall thermal transmittance of walk-in panels. (ASAP, No. 13 at p. 2; CA IOUs, No. 14 at p. 5) The CA IOUs specifically recommended that the ASTM C1363 test be conducted on a wall panel assembly that includes the panel joint to ensure the joint locking mechanism does not significantly affect the thermal conductance of the assembly. The CA IOUs also suggested that the tested joint assembly use a manufacturer-recommended sealant representative of field installation. (CA IOUs, No. 14 at p. 5)

Imperial Brown urged DOE to maintain the current test procedure for non-display panels based on insulation R-values determined using ASTM C518. Imperial Brown stated that ASTM C1363 is unduly burdensome given the custom nature of the walk-ins they manufacture and that this would substantially increase their testing requirements. Imperial Brown also remarked that the effect of panel edges or accessories is of little value to the overall energy consumption of a walk-in and that considering these effects would be equivalent to considering one opening of the walk-in door per day. Specifically, Imperial Brown stated that the panel edges and accessories are not considered when calculating box loads and sizing refrigeration equipment because they do not consider them to be an important factor in heat loss. Imperial Brown also stressed that retesting will be required every few years as they switch to different insulation chemicals to comply with other regulations coming into effect (*e.g.,* the Environmental Protection Agency (''EPA'') phasedown of HFCs. (Imperial Brown, No. 15 at p. 3)

NFRC stated that all labs qualified to run NFRC 102 are qualified to run ASTM C1363 and that there are currently ten labs accredited by NFRC to run NFRC 102, and thus ASTM C1363. (NFRC, No. 10 at p. 4)

While commenters indicated that there are more laboratory facilities now able to conduct an overall U-factor test procedure, the concerns previously expressed regarding cost and test burden, which led to the removal of this test procedure in the May 2014 AEDM final rule (79 FR 27388, 27405–27406), remain. At this time, DOE is not proposing to include a test procedure for determining energy consumption of non-display panels and is proposing to maintain the R-value of insulation test procedure in appendix B with the proposed amendments as described previously in sections III.E.1 through III.E.4.

F. Proposed Amendments to Subpart R, Appendix C, to Determine Compliance With the Current Energy Conservation Standards

Subpart R, appendix C, provides the test procedures to determine the AWEF and net capacity of walk-in refrigeration

[27] Thermal bridging occurs when a more conductive material allows an easy pathway for heat flow across a thermal barrier.

systems. DOE is proposing to modify subpart R, appendix C, to improve test representativeness and repeatability. Specifically, DOE is proposing to make the following revisions to subpart R, appendix C: (1) Specify refrigeration test room conditions; (2) provide for a temperature probe exception for small diameter refrigerant lines; (3) incorporate a test setup hierarchy for laboratories to follow when setting up a unit for test; (4) allow active cooling of the liquid line in order to achieve the required 3 °F subcooling at a refrigerant mass flow meter; and (5) modify instrument accuracy and test tolerances.

DOE does not expect that the changes it is proposing in this section would alter measured capacity values or AWEF—which means that no retesting or recertification would be required. Rather, the revisions proposed for subpart R, appendix C, address repeatability issues that DOE has observed through its testing of walk-in refrigeration systems.

The following sections describe the modifications that DOE is proposing to subpart R, appendix C.

1. Refrigeration Test Room Conditioning

The DOE test procedure for walk-in refrigeration systems has requirements for test chambers to be at specific temperature and/or humidity conditions. (*See, e.g.,* Tables 3 through 16 of AHRI 1250–2009, which is incorporated by reference in the DOE test procedure) Section C6.2 of AHRI 1250–2009 appendix C requires that the environmental chambers ''be equipped with essential air handling units and controllers to process and maintain the enclosed air to any required test conditions.'' This same requirement is in Section C5.2.2 of AHRI 1250–2020. However, DOE is aware that some test facilities rely on the test unit to cool and dehumidify the test room, in some cases without support from additional chamber conditioning systems. When unit coolers with hot gas defrost are tested and certified alone, these unit coolers may be paired with a condensing unit at a test facility that lacks hot gas capability and would be unable to remove the frost accumulated during pretest conditioning. Such frost would affect the results of the capacity test.

DOE proposes to specify that for applicable system configurations (matched pairs, single-packaged systems, and unit coolers tested alone), the unit under test may be used to aid in achieving the required test chamber conditions prior to beginning any steady state test. However, the unit under test must be inspected and confirmed to be free from frost before initiating steady state testing. This additional instruction reflects DOE's understanding of the existing practice followed by manufacturers and third-party laboratories who use the unit under test to establish the required chamber conditions. The proposed inspection requirement would ensure that a steady state test is not started with frost on the coil. Starting a test with a frosted coil would likely lead to reduced-efficiency and non-representative test results, and DOE expects that test laboratories would have no incentive to conduct tests with a frosted coil.

Issue 12: DOE requests comment on the proposed pretest coil inspection requirement. DOE requests comment on whether the proposed approach is inconsistent in any way with the way units under test are used to assist in chamber conditioning by testing facilities, and if so, in what way are the proposals inconsistent, and how could they be changed to align with this practice.

2. Temperature Measurement Requirements

The current DOE test procedure requires all refrigerant temperature measurements entering or leaving the unit cooler be measured by a ''temperature measuring instrument placed in a thermometer well and inserted into the refrigerant stream. These wells shall be filled with non-solidifying, thermal conducting liquid or paste to ensure the temperature sensing instrument is exposed to a representative temperature.'' AHRI 1250–2009 appendix C, Section C3.1.6. These temperature measurements are used to determine refrigerant enthalpy as part of the capacity measurement for matched pairs and unit coolers tested alone (*see* AHRI 1250–2009, Section C8.5.1, Equations C1 and C2). However, the capacity determination for dedicated condensing units tested alone is based on the refrigerant conditions leaving the condensing unit and standardized conditions leaving the unit cooler, as specified in section 3.4.2.1 of subpart R, appendix C. DOE believes that the added accuracy provided by immersing the temperature sensor in the refrigerant or by the thermometer wells should be applied for the temperature measurement used in the capacity calculation. Hence, DOE proposes that the test procedure provide clarification that when testing dedicated condensing units, the use of thermometer wells or immersed sensors be used only at the condensing unit liquid outlet. DOE believes this may reduce testing burden in cases where labs have been using two sets of refrigerant-immersed temperature measurements when testing dedicated condensing units alone.

Issue 13: DOE requests comment on its proposal to require use of thermometer wells or sheathed sensors immersed in the refrigerant when measuring temperature at the liquid outlet of the condensing unit and to forego the requirement for this measurement technique for the suction line when testing a dedicated condensing unit alone.

DOE has found that implementing the current thermometer well requirement for refrigerant lines with outer diameter ½-inch or less can restrict the refrigerant flow and thus affect the measurements. To rectify this issue and to ensure that all walk-in refrigeration systems can be tested according to the DOE test procedure, DOE proposes allowing an alternative approach when the refrigerant line tubing diameter is ½-inch or less in which the temperature measurement would be made using two surface-mounted measuring instruments with a minimum accuracy of ±0.5 °F, which would be averaged to obtain the reading. DOE notes that when using the Dual Instrumentation method described in Section C8 of AHRI 1250–2009 appendix C, the two surface measurements described would constitute one temperature measurement, rather than the two measurements required for the test method. Additionally, DOE proposes that the two measuring instruments must be mounted on the pipe separated by 180-degrees around the refrigerant tube circumference. To ensure measurements are not affected by changes in ambient temperature, DOE proposes requiring use of 1-inch-thick insulation around the measuring instruments that extends 6-inches up- and down-stream of the measurement locations. Where this technique is used to measure temperature at the expansion valve inlet, *i.e.,* where Section C3.16 of AHRI 1250–2009 requires the measurement to be within 6 pipe diameters of the control device, DOE proposes to relax this requirement and require instead that the measurement be within 6 inches of the device.

Issue 14: DOE requests comment on its proposal to allow the use of two temperature measuring instruments, placed on the outside of refrigerant tubing that is less than or equal to ½-inch, for the measurement of refrigerant temperature where the current test procedure requirement is to use thermometer wells or a sheathed sensor immersed in the refrigerant.

3. Hierarchy of Installation Instructions and Specified Refrigerant Conditions for Refrigerant Charging and Setting Refrigerant Conditions

During testing, DOE has found that some refrigeration systems cannot be set up fully consistent with the refrigerant conditions specified in installation instructions. In some cases, there may be multiple installation instructions (*e.g.,* instructions on labels affixed to the unit and instructions shipped with the unit), and different results could be obtained depending on which instructions are followed. To address this issue, DOE has developed a setup hierarchy for installation instructions and setup of refrigerant conditions to improve repeatability in testing by indicating which manufacturer-specified conditions would be prioritized during test setup. DOE's proposed setup hierarchy is discussed in more detail in the following paragraphs.

Setup conditions or instructions may be stamped on the unit nameplate or otherwise affixed to the unit, shipped with the unit, or available online. DOE has encountered walk-in refrigeration units for which these three sources of instruction provide different values or conflicting directions. To ensure consistent setup during testing, DOE proposes that instructions or conditions stamped on or adhered to a test unit take precedence, followed by instructions shipped with the unit. Additionally, since online instructions can be easily revised, DOE proposes that instructions or other setup information found online would not be used to set up the unit for test.

Setting of refrigerant charge level or refrigerant conditions is a key aspect of setup of refrigeration systems, whether for field use or testing. DOE proposes that units be charged and set up at operating conditions specified in the test procedure (for outdoor refrigeration systems, DOE proposes use of operating condition A) based on the installation instructions, using the proposed hierarchy (*i.e.,* prioritize instructions stamped or adhered to unit over instructions included in a manual shipped with the unit). In the case where instructions for refrigerant charging or refrigerant conditions are provided only in online instructions or not at all, DOE is proposing that a generic charging approach be used instead. If the installation instructions specify operating conditions to use to set up the refrigerant charge or refrigerant conditions, that operating condition would be used rather than the conditions specified in the test procedure.

DOE often finds that in some cases, the manufacturer specifies a range of conditions for superheat,[28] subcooling, and/or refrigerant pressure. If this is the case, DOE proposes to treat the midpoint of that range as the target temperature/pressure, and that a test condition tolerance would be applied to the parameter that is equal to half the range. For example, if a manufacturer specifies a target superheat of 5 to 10 °F, the target for test would be 7.5 °F and that the average value during operation at the setup operating conditions would have to be 7.5 °F ± 2.5 °F. Alternatively, installation instructions may specify a refrigerant condition value without a range or without indicated tolerances. In such cases, DOE proposes that standardized tolerances be applied as indicated in Table III.6. These tolerances depend on the kind of refrigerant expansion device used.

DOE also notes that zeotropic [29] refrigerants have become more common. When charging with such refrigerants (*i.e.,* any 400 series refrigerant), DOE proposes that the refrigerant charged into the system must be in liquid form. This is standard practice for charging of such refrigerants since the concentrations of the components of the blend present in the vapor phase of the charging cylinder are often skewed from the intended concentrations of the refrigerant blend.

If the installation instructions on the label affixed to (or shipped with) the unit do not provide instructions for setting subcooling or otherwise how to charge it with refrigerant for a condensing unit tested alone, or tested as part of a matched pair, DOE proposes requiring that the unit be tested in a way that is consistent with the DOE test procedure and the installation instructions and also does not cause the unit to stop operating during testing, *e.g.,* by shutoff by the high pressure switch. DOE believes that such installation would be most representative of the way a technician would set up a system in the field if there were no refrigerant charge or subcooling instructions.

a. Dedicated Condensing Unit Charging Instructions

For dedicated condensing units tested alone, subcooling is the primary setup condition. DOE is proposing that if the dedicated condensing unit includes a receiver and the subcooling target leaving the condensing unit provided in the installation instructions cannot be met without fully filling the receiver, the subcooling target would be ignored. Likewise, if the dedicated condensing unit does not include a receiver and the subcooling target leaving the condensing unit cannot be met without the unit cycling off on high pressure, the subcooling target would be ignored. Also, if no instructions for charging or for setting subcooling leaving the condensing unit are provided in the installation instructions, DOE is proposing that the refrigeration system would be set up with a charge quantity and/or exit subcooling such that the unit operates during testing without shutdown (*e.g.,* on a high-pressure switch) and operation of the unit is otherwise consistent with the requirements of the test procedure and the installation instructions.

b. Unit Cooler Charging Instructions

For unit coolers tested alone, superheat is the primary setup condition. Most WICF refrigeration systems use either thermostatic or electronic expansion valves that respond either mechanically or through a controller to adjust valve position to control for superheat leaving the unit cooler. If the unit under test is shipped with an adjustable expansion device, DOE proposes that this would be the primary method to adjust superheat. However, DOE has encountered units with expansion devices that are not adjustable or where the expansion device does not provide a sufficient range of adjustment to achieve the superheat target. If the expansion valve associated with the unit under test reaches its limit before the superheat target is met, the specified superheat may not be met within the specified tolerance. In this case, DOE proposes that the expansion valve should be left at the adjustment limit achieving the closest match to the superheat target.

DOE has also encountered mis-matched expansion devices and unit coolers. In this situation, DOE proposes that any expansion device specified for use with the unit cooler in manufacturer literature may be used for the purposes of DOE testing.

Also, DOE proposes that an operating tolerance would not apply to superheat. Hence, in the event that the expansion valve control of the systems is not steady, *i.e.,* if so-called ''hunting'' occurs, in which the valve position, temperatures, and/or pressures are unsteady, this fluctuation would not

[28] Superheat is the difference between vapor-phase refrigerant temperature and the dew point corresponding to the pressure level.

[29] A zeotropic refrigerant is a blend of two or more refrigerants that have different boiling points. Each refrigerant will evaporate and condense at different temperatures.

invalidate a test. However, if the fluctuations are so great that a valid test cannot be performed (*i.e.,* any individual measurement of superheat during the test is zero or less, or if the operating tolerances for measurements that would be affected by expansion device hunting are exceeded (mass flow, pressure at the unit cooler exit, evaporator temperature difference),[30] the test procedure would call for remedial action allowing deviation from the installation instructions. The remedial action would be, at the discretion of the test laboratory, replacing the expansion device with a different expansion device that does not need to be listed in installation instructions, adjusting the expansion device to provide an average superheat that is greater than the target superheat, or both.

If the installation instructions on the label affixed to the unit or shipped with the unit do not provide instructions for setting superheat for a unit cooler tested alone or tested as part of a matched pair, DOE proposes that the target superheat would be 6.5 °F, the same value required in such circumstances in AHRI 1250–2020 (see footnotes to Tables 16 and 17 of AHRI 1250–2020).

c. Single-Packaged Dedicated System Setup and Charging Instructions

DOE has identified multiple setup issues while testing single-packaged dedicated systems. Compared to split refrigeration systems,[31] single-packaged dedicated systems have less adjustment flexibility due to lack of controls. Additionally, many single-packaged dedicated systems are marketed as ''fully charged''; therefore, it could be assumed that the charge would not need to be adjusted.

DOE proposes that one or more pressure gauges, depending on the number of conditions which require a pressure measurement for validation, should be installed during the setup according to installation instructions to evaluate the charge of the unit under test and to accurately measure setup conditions. The location of the pressure gauge(s) would depend on the test setup conditions given in the installation instructions. If charging is based on subcooling or liquid pressure, DOE proposes that the pressure gauge would be installed at the service valve of the liquid line. If charging is based on superheat, low side pressure, or a corresponding saturation temperature/dew point temperature, DOE proposes that the pressure gauge(s) would be placed in the suction line.

DOE is aware that installation instructions for some single-packaged dedicated systems recommend against installing charging ports; however, DOE has observed through testing that some of these units do not operate once installed due to high- or low-pressure compressor cut off, which is often a symptom of under- or over-charging or refrigerant loss. These units are representative of what a contractor would encounter when installing a walk-in single-packaged unit in the field. Therefore, in cases where a unit under test is not operating due to high- or low-pressure compressor cut off, DOE proposes a charging port should be installed, the unit should be evacuated, and the nameplate charge should be added. This approach would eliminate under- or over-charging of the unit which would address compressor cut off.

d. Hierarchy of Setup Conditions if Manufacturer-Specified Setup Conditions Cannot be Met

In DOE's experience, even when all the previously discussed measures are implemented during test setup, some manufacturer specified setup conditions may not be met. If this is the case, DOE is proposing that the unit under test be set up according to a hierarchy of conditions similar to those used for central air-conditioning systems and heat pumps. First, the installation instruction hierarchy previously discussed would be applied. Specifically, if a refrigerant-related setup instruction in the installation instructions affixed to the unit and a different instruction in the installation instructions shipped with the unit cannot both be achieved within tolerance, the instruction on the label takes precedence. Further, if multiple instructions within the relevant installation instructions cannot be met, the proposed hierarchy outlined in Table III.6 would be applied. The highest priority condition that can be satisfied, based on Table III.6, would need to be met, depending on what kind of expansion device the system uses. This approach would ensure that units are set up consistently across testing facilities, ensuring more consistent results.

TABLE III.6—TEST CONDITION TOLERANCES AND HIERARCHY FOR REFRIGERANT CHARGING AND SETTING OF REFRIGERANT CONDITIONS

Fixed orifice or capillary tube			Expansion valve		
Priority	Method	Tolerance	Priority	Method	Tolerance
1	Superheat	±2.0 °F	1	Subcooling	10% of the Target Value; No less than ±0.5 °F, No more than ±2.0 °F.
2	High Side Pressure or Saturation Temperature.	±4.0 psi or ±1.0 °F	2	High Side Pressure or Saturation Temperature.	±4.0 psi or ±1.0 °F.
3	Low Side Pressure or Saturation Temperature.	±2.0 psi or ±0.8 °F	3	Superheat	±2.0 °F.
4	Low Side Temperature	±2.0 °F	4	Low Side Pressure or Saturation Temperature.	±2.0 psi or ±0.8 °F.
5	High Side Temperature	±2.0 °F	5	Approach Temperature	±1.0 °F.
6	Charge Weight	±2.0 oz	6	Charge Weight	0.5% or 1.0 oz, whichever is greater.

[30] Evaporator Temperature Difference (TD) is the difference in temperature between the entering air and the refrigerant dew point of the exiting refrigerant.

[31] ''Split refrigeration systems'' refer to systems made up of a condensing unit and a unit cooler that are connected by refrigerant lines and are not contained in a single housing. Split refrigeration systems could be field-matched condensing units and unit coolers or condensing units and unit coolers sold as matched pairs.

Issue 15: DOE requests comment on its proposals discussed in this section regarding set up of walk-in refrigeration systems for testing to achieve manufacturer-specified conditions for superheat, subcooling, high-side temperature, pressure or saturation temperature, low-side temperature, pressure or saturation temperature, and refrigerant charge weight. Additionally, DOE requests comment on the proposed hierarchy presented in Table III.6, if a laboratory has confirmed that the unit is properly charged.

4. Subcooling Requirement for Mass Flow Meters

DOE has found that for testing dedicated condensing units alone an appropriate subcooling temperature ensures that the refrigerant is fully liquid at the mass flow meter, providing an accurate measurement. A mass flow meter may provide an inaccurate flow rate if the refrigerant is a mixture of vapor and liquid at the point of measurement. Section C3.4.5 of AHRI 1250–2009 appendix C requires that refrigerant be subcooled to at least 3 °F and that bubbles not be visible in a sight glass immediately downstream of the mass flow meter. Section 3.2.3 of subpart R, appendix C, allows use of the sight glass and a temperature sensor located on the tube surface under the insulation to verify sufficient subcooling. DOE testing has also shown that even when the subcooling requirement is met downstream of the mass flow meters, the subcooling can be significantly lower upstream of the mass flow meters, resulting in questionable mass flow measurements that do not provide capacity determinations within the required tolerances, *e.g.,* with 5 percent of each other as required by Section C8.5.3 of AHRI 1250–2009 (*see* EERE–2017–BT–TP–0010–0021, ''Development of Test Rating Conditions for Two-Capacity, Multiple-Capacity, and Variable-Capacity Condensing Units''). DOE proposes to add further instruction to section 3.2.3 of subpart R, appendix C.

First, DOE proposes that the 3 °F subcooling requirement be applied at a location depending on location of the liquid-line mass flow meters. Specifically, the requirement would apply downstream of any mass flow meter located in the chamber in which the condensing unit under test is located, consistent with AHRI 1250–2009. However, for mass flow meters located in the chamber in which the unit cooler under test is located, the subcooling would have to be verified upstream of the mass flow meter. The latter requirement addresses observation in DOE testing that the upstream subcooling is less than the downstream subcooling when the mass flow meter is in the same chamber as the unit cooler. *Id.* This occurs because the unit cooler chamber is generally much cooler than the liquid refrigerant.[32] Since mass flow meters are rarely insulated, the liquid refrigerant is cooled as it passes through the mass flow meter, which increases the refrigerant's subcooling. However, as the liquid refrigerant passes through the mass flow meter it also experiences a pressure drop which decreases the subcooling. The increase in subcooling that occurs across the mass flow meter is nearly always larger than the decrease in subcooling that occurs because of the pressure drop across the mass flow meter. Therefore, subcooling will nearly always be less at the inlet of a mass flow meter than at the outlet. This is in contrast to a mass flow meter located in the same chamber as the condensing unit, for which the air surrounding the mass flow meter, while typically cooler than the liquid, would be much closer in temperature to the liquid temperature.[33] DOE also notes that the requirement for subcooling specified in ASHRAE 23.1–2010, which is incorporated by reference by the DOE test procedure for testing of condensing units alone, indicates in section 7.1.2 (''Adequate subcooling shall be provided upstream of a liquid refrigerant flowmeter . . .'') suggesting that there is a lack of clarity regarding the best location for ensuring adequate subcooling. Based on DOE's experience and the prevailing air-liquid temperature differences during testing, DOE proposes to include the clarification above regarding the location of the subcooling verification.

Second, DOE proposes to indicate that active cooling of the liquid line may be used to achieve the required subcooling, since the subcooling at the mass flow meter outlet may not meet the 3 °F requirement when the subcooling at the condensing unit exit is within tolerance of its target. However, DOE also proposes requiring that if this is done when testing a matched pair (not including single-packaged dedicated systems), that the temperature also must be measured upstream of the location where cooling is provided, and that the temperature used to calculate the enthalpy of the refrigerant entering the unit cooler be increased by the difference between the upstream and downstream measurements. DOE is proposing this adjustment so that active cooling of the liquid to obtain a mass flow measurement does not provide a non-representative boost in calculated cooling capacity.

DOE proposes to add these requirements to subpart R, appendix C, which would also carry over to the newly proposed subpart R, appendix C1.

Issue 16: DOE requests comments on its proposal to clarify the location where the 3 °F subcooling requirement would apply and to require active cooling of the liquid line in order to achieve the required 3 °F subcooling at a refrigerant mass flow meter. DOE also seeks comment on its proposal to require, for matched pairs, adjustment of the measured unit cooler inlet temperature by the difference in temperatures measured upstream and downstream of the active cooling in order to calculate the inlet enthalpy in the capacity calculation.

5. Instrument Accuracy and Test Tolerances

As discussed in section III.B.3.a, AHRI 1250–2020 has adopted language from the current DOE test procedure covering test tolerances and instrumentation accuracy. Additionally, as discussed in section III.B.3.d, some tolerances and instrumentation accuracy requirements in AHRI 1250–2020 are not consistent with the current DOE test procedure. DOE is proposing to adopt these changes from AHRI 1250–2020 into subpart R, appendix C, as DOE has tentatively determined these changes would not have an effect on measured values.

AHRI 1250–2020 changes the measurement accuracy for the temperature of air entering or leaving either the evaporator or condenser to ± 0.25 °F from ± 0.2 °F in AHRI 1250–2009. DOE notes that ± 0.25 °F is the standard minimum accuracy across many Heating, Ventilation and Air-Conditioning (''HVAC'') testing standards. Since AHRI 1250–2020 references AHSRAE 37–2009 for single-packaged testing, it simplifies the test procedure to have the same instrument accuracy requirements across both standards. In addition, providing a consistent minimum accuracy across test procedures reduces laboratory test burden and DOE expects it may benefit a laboratory's quality control. DOE is

[32] For example, when testing a matched pair refrigerator system under test condition A, the condensing unit chamber air temperature is at 95 °F and the unit cooler chamber air is at 35 °F. The liquid refrigerant generally is warmer than the condensing unit ambient temperature. Hence, there is at least a 60 °F temperature difference between the unit cooler inlet air temperature and the liquid refrigerant temperature.

[33] For the same example, the liquid temperature may be in the range roughly from 95 °F to 105 °F, at most about 10 °F warmer than the surrounding air.

proposing that the temperature measurement of air entering or leaving either the compressor or evaporator would have a minimum accuracy of ± 0.25 °F. DOE does not expect this modification to have a significant impact on measured values. Additionally, the proposed tolerance is greater than the current tolerance and therefore if adopted it would not require manufacturers to retest. DOE does not expect that the changed tolerance would impact the representativeness of the results. As noted, the proposed tolerance is that generally used for HVAC systems.

As discussed in section III.B.3.d, AHRI 1250–2020 does not reference ASHRAE 23 or AHRI 420 for the testing of dedicated condensing units and unit coolers, respectively. As such, the ASHRAE 23 refrigerant mass flow operating tolerance of ± one percent of the quantity measured has been replaced in Table 2 of AHRI 1250–2020 by an operating tolerance of 3 pounds per hour (''lb/h'') or 2 percent of the reading (whichever is greater). DOE notes that the requirement for a one percent mass flow tolerance posed challenges for test labs when at very low flow rates (near 0 lb/h). Specifically, as mass flow approaches 0 lb/h, the acceptable deviation from the average also approaches zero resulting in an unrealistic accuracy target. This issue would not occur with the minimum accuracy provided in AHRI 1250–2020 because the acceptable deviation from the average must be within ± 3 lb/h if the variation is less than 2 percent of the mass flow reading. As such, DOE is proposing to adopt the mass flow tolerance specified in Table 2 of AHRI 1250–2020 into subpart R, appendix C. DOE does not expect that this modification would have a significant impact on capacity and AWEF values, and therefore would not require retesting or recertification.

6. CO_2 Unit Coolers

All refrigerants have a ''critical pressure'' and an associated ''critical temperature'' above which liquid and vapor phases cannot coexist. Above this critical point, the refrigerant will be a gas and its temperature will increase or decrease as heat is added or removed. For all conventional refrigerants, the critical pressure is so high that it is never exceeded in typical refrigeration cycles. For example, R404A is a common refrigerant used in refrigeration systems that has a critical pressure of 540.8 psia [34] with an associated critical temperature of 161.7 °F. However, CO_2 behaves differently, with a critical pressure of 1,072 psia associated with a lower critical temperature of 87.8 °F. The refrigerant temperature must be somewhat higher than the ambient temperature in order to reject refrigeration cycle heat to the ambient environment. Ambient temperatures greater than 87.8 °F are common and the performance of many refrigeration and air conditioning systems are tested using a 95 °F ambient temperature, as indicated by the A test condition in Section 5 of AHRI 1250–2009 (and AHRI 1250–2020). At temperatures greater than the critical temperature, the CO_2 refrigerant is in a supercritical state (*i.e.,* a condition with pressure above the critical temperature). Since useful cooling is provided below the critical temperature, CO_2 cycles are said to be transcritical.

DOE has granted test procedure waivers to the manufacturers listed in Table III.1 for certain basic models of walk-in refrigeration systems that use CO_2 as a refrigerant. Manufacturers requesting a waiver from the DOE test procedure for CO_2 unit coolers stated that the test conditions described in Tables 15 and 16 of AHRI 1250–2009, as incorporated by subpart R, appendix C, with modification, cannot be achieved by, and are not consistent with the operation of, CO_2 direct expansion unit coolers. These manufacturers also specified that CO_2 has a critical temperature of 87.8 °F, and therefore the required liquid inlet saturation temperature of 105 °F and the required liquid inlet subcooling temperature of 9 °F as specified in the DOE test procedure are not achievable. The alternate test procedure provided in these waivers modifies the test condition values to reflect typical operating conditions for a transcritical CO_2 booster system. Specifically, the waiver test procedures require that CO_2 unit cooler testing is conducted at a liquid inlet saturation temperature of 38 °F and a liquid inlet subcooling temperature of 5 °F. CO_2 that is cooled in the gas cooler of a transcritical booster system expands through a high-pressure control valve that delivers CO_2 to a subcritical-pressure flash tank, where liquid and vapor phases of the refrigerant are separated. The liquid is then split, and the unit cooler, regardless of refrigerated storage space temperature, receives the refrigerant at the same condition. This applies to both medium- and low-temperature systems.

In the June 2021 RFI, DOE requested comment on whether the test conditions provided in the waivers are appropriate and if there are additional modifications that could more accurately evaluate the energy use of these systems while minimizing test burden. 86 FR 32332, 32346. Lennox, AHRI, National Refrigeration, and Hussmann recommended that DOE use the conditions provided in the waivers for CO_2 unit coolers. (Lennox, No. 9 at p. 7; AHRI, No. 11 at p. 12; National Refrigeration, No. 17 at p. 1; Hussmann, No. 18 at p. 14)

In the June 2021 RFI, DOE also requested comment on the present and future expected use of CO_2 systems and information about such systems that would suggest a need to modify the DOE test procedure. 86 FR 32332, 32346. Lennox, AHRI, and Hussmann stated that some CO_2 units, not available in the U.S., may supply subcritical liquid or supercritical gas at the expansion valve, while some condensing units with integrated expansion valves supply two-phase CO_2 to evaporators. (Lennox, No. 9 at pp. 7–8; AHRI, No. 11 at pp. 12–13; Hussmann, No. 18 at p. 14) For units where the CO_2 leaving the condensing unit is supercritical or two-phase, Lennox, AHRI, and Hussmann recommended setting temperature *and* pressure conditions; for condensing units providing subcritical liquid to unit cooler expansion devices, these stakeholders suggested that the test method provided in the waivers should be used. (Lennox, No. 9 at p. 8; AHRI, No. 11 at p. 13; Hussmann, No. 18 at p. 14) Lennox, AHRI, and Hussmann additionally stated that while CO_2 condensing units with a single compression stage and conventional HFC units can be tested using the same method, an intermediate pressure that is the same as the liquid supply conditions in the waiver test procedures must be specified for units with two stages of compression. *Id.* Lennox recommended evaluating the potential energy savings of CO_2 units to see if additional changes are warranted. (Lennox, No. 9 at p. 7) The CA IOUs suggested that DOE differentiate AWEF ratings of units using CO_2 and units using traditional refrigerants. (CA IOUs, No. 14 at p. 4) Additionally, the CA IOUs urged DOE to ensure that the walk-in test procedures and metrics continue to provide consumers with the information necessary to easily compare the performance of products with the same utility. *Id.*

DOE acknowledges that a goal of its test procedures is to provide purchasers

[34] Absolute pressure is the pressure measured relative to a complete vacuum; ''psia'' represents the absolute pressure in pounds per square inch.

with an energy use metric that is consistent across products that provide similar utility. In response to the comment by Lennox, DOE would evaluate the potential energy savings of CO_2 units as part of a separate, future energy conservation standards rulemaking. DOE investigation confirms that there are no known sales of CO_2 dedicated condensing units in the U.S. The only relevant CO_2 system architecture in the U.S. appears to be CO_2 booster systems using unit coolers operating with conditions consistent with the waivers.

DOE also evaluated if the current AWEF calculation for unit coolers tested alone could be applied to CO_2 unit coolers. The current calculation uses an EER to determine the representative compressor power consumption. The EER values used are in Table 18 of AHRI 1250–2020 and are based on typical traditional refrigerant compressor efficiency. DOE has tentatively determined that the EER values used for the AWEF calculations of traditional unit coolers can also be used for CO_2 unit coolers. DOE research into the performance of different configurations of CO_2 booster systems shows that enhanced CO_2 cycles can match conventional refrigerants in average annual efficiency. These data and studies help to justify the use of the EER values in Table 18 of AHRI 1250–2020 for determining the power consumption of CO_2 booster system unit coolers, even though these EER values were initially established for conventional refrigerants.

In this NOPR, DOE is proposing to adopt in subpart R, appendix C (and also appendix C1), the alternate test conditions specified in the waivers that DOE granted for CO_2 transcritical unit coolers for all CO_2 unit coolers. Also, consistent with the waiver alternate test procedures, DOE proposes that the established EER values be used to determine compressor power found in Table 17 of AHRI 1250–2009 (or Table 18 of AHRI 1250–2020 for appendix C1) would be used to determine the AWEF of all CO_2 unit coolers.

Issue 17: DOE requests comment on the appropriateness of traditional refrigerant compressor EER values for use in CO2 unit cooler AWEF calculations.

7. High-Temperature Unit Coolers

As discussed in the June 2021 RFI, DOE is aware of wine cellar (high-temperature) refrigeration systems that fall within the walk-in definition but that may be incapable of being tested in a manner that would yield representative performance results during a representative average use cycle under the current version of the walk-in test procedure. 86 FR 32332, 32344. For example, wine cellar refrigeration systems that may be installed in some commercial settings are designed to operate at a temperature range of 45 °F to 65 °F.

High-temperature refrigeration systems are discussed generally in section III.G.6. Most of these refrigeration systems are either a single-packaged dedicated system or a matched pair. However, DOE has also received a petition for waiver for high-temperature unit coolers that are distributed into commerce without a paired condensing system.[35] These unit cooler-only models would be tested according to the provisions in the test procedure for unit coolers tested alone, for which calculation of AWEF requires use of an appropriate EER based on the suction dew point temperature. Table 17 in AHRI 1250–2009 provides EER values for medium- and low-temperature unit coolers tested alone. However, DOE has tentatively determined that these values are not appropriate for calculating AWEF for high-temperature unit coolers because this equipment operates with a different suction dew point temperature and the counterpart dedicated condensing units likely use different compressor designs than those considered when developing the EER values included in AHRI 1250–2020.

In the June 2021 RFI, DOE requested data on appropriate EER values for use with high-temperature unit coolers and questioned how these values might depend on refrigerant or capacity. 86 FR 32332, 32345. AHRI stated that they did not have data to support EER values for use in determining AWEF for wine cellar unit coolers since most systems are sold as a matched pair. (AHRI, No. 11 at p. 11) In the June 2021 RFI, DOE also requested information on dedicated condensing units that would typically be paired with high-temperature unit coolers. 86 FR 32332, 32345–32346. Lennox and AHRI stated that there are no definitive characteristics for unit coolers that are sold for use in wine cellar refrigeration applications, and that many units are sold to users as pairs matched by contractors. (Lennox, No. 9 at pp. 6–7; AHRI, No. 11 at pp. 11–12)

In its market evaluation, DOE has observed that a majority of high-temperature refrigeration systems are sold as matched pairs or single-packaged systems. While unit coolers sold for high-temperature walk-in cooler applications are sold separately, DOE was unable to find any dedicated condensing units marketed specifically for high-temperature walk-in applications. Thus, DOE could not use the performance data of such dedicated condensing unit models to provide an indication of the appropriate EER for dedicated condensing units paired with such high-temperature unit coolers. Rather, consistent with the interim waiver granted to LRC, DOE is proposing EER values developed using compressor performance data from Emerson and Tecumseh product websites (EERE–2020–BT–WAV–0040, No. 2 and No. 8, respectively) for high-temperature refrigeration compressor models within the applicable capacity range (2,900 Btu/h to 36,000 Btu/h). DOE expects that the dedicated condensing units paired with high-temperature walk-in unit coolers would use hermetic reciprocating compressors at lower capacities and hermetic scroll compressors at higher capacities. Also, DOE developed the EER values based on compressors rated for use with HFC–134a, R404A, or R407C refrigerants. Based on these compressor performance data, DOE calculated representative compressor EER levels for wine cellar walk-in unit coolers using the following parameters:

- 38 °F unit cooler exit dew point condition, as suggested by LRC (EERE–2020–BT–WAV–0040, No. 1 at p. 3).
- 2 °F equivalent suction line dew point pressure drop, consistent with AHRI 1250–2009 section 7.9.1.
- 7 °F evaporator exit superheat, rounding to whole number values of the 6.5 °F superheat test condition prescribed in the footnote to Table 15 of subpart R, appendix C, in case a value is not provided in an installation manual.
- 55 °F refrigerant temperature entering the compressor, representing a 10 °F refrigerant vapor temperature rise in the suction line, consistent with the temperature rise implied for medium-temperature refrigeration system test conditions.[36]

[35] LRC Coil Company submitted a petition for waiver and interim waiver for specific basic models of unit cooler only walk-in wine cellar refrigeration systems. (LRC Coil, EERE–2020–BT–WAV–0040, No. 1) In reviewing another petition for waiver and interim waiver from Vinotheque for single-packaged system and matched pair system basic models (Vinotheque, EERE–2019–BT–WAV–0038, No. 6), DOE noted that the manufacturer also offered unit cooler-only systems distributed without a paired condensing system.

[36] AHRI 1250–2009 Table 11 prescribes a return gas temperature (measured at the condensing unit inlet location) equal to 41 °F for testing medium temperature dedicated condensing units. Also, Table 15 and section 3.3.1 of appendix C prescribe testing medium-temperature unit coolers using 25 °F saturated suction temperature (this is the same

• 90 °F annual average condensing temperature. This assumes that the condensing unit serving the unit cooler would be located outdoors and that head pressure control would prevent excessively cold condensing operation at cold outdoor temperatures.[37]

DOE plotted the calculated compressor EER values versus calculated unit cooler capacity and noted that the EER can significantly vary with capacity. (EERE–2020–BT–WAV–0040, No. 9) EER is generally lower for low-capacity compressors and higher for high-capacity compressors, with a transition region in between. Based on the plotted calculations, DOE determined for the purpose of the interim waiver that a representative value for EER should depend on capacity. As such, DOE developed different functions of EER for three distinct capacity ranges. Table III.7 summarizes these capacity ranges and EER functions for high-temperature compressors.

TABLE III.7—EER VALUES FOR HIGH TEMPERATURE COMPRESSORS AS A FUNCTION OF CAPACITY FOR HIGH-TEMPERATURE REFRIGERATION SYSTEMS

Capacity (Btu/hr)	EER (Btu/Wh)
<10,000	11
10,000–19,999	(0.0007 × Capacity) + 4
20,000–36,000	18

The LRC interim waiver includes additional test procedure provisions to obtain representations that are representative for high-temperature unit coolers, including both testing requirements and AWEF calculation requirements. These include provisions for setting ducted fan-coil unit evaporator systems.

DOE proposes to include provisions for testing high-temperature unit coolers in subpart R, appendix C. These provisions, consistent with the LRC interim waiver, would include test conditions for testing these unit coolers at high-temperature refrigeration conditions, as well as EER values described previously for calculation of AWEF. DOE also proposes to include these provisions in appendix C1.

Issue 18: DOE requests comment on its proposals to adopt test procedure provisions for high-temperature unit coolers in appendices C and C1 of 10 CFR part 431, subpart R.

G. Proposal To Establish Appendix C1

In this NOPR, DOE is proposing to establish a new appendix C1 to subpart R of part 431, which would be required to demonstrate compliance coincident with the compliance date of any amended energy conservation standards that DOE may promulgate as part of a separate standards rulemaking. Certain proposed modifications to the test procedure are expected to alter measured values, and such changes are contained in the proposed appendix C1. DOE has tentatively determined that AHRI 1250–2020 improves representativeness of the walk-in refrigeration system test procedure by incorporating off-cycle measurement for components in addition to off-cycle fan power and providing test options for single-packaged dedicated systems, in addition to other changes. Therefore, DOE is proposing to incorporate AHRI 1250–2020 by reference into its proposed test procedure at appendix C1 for walk-in refrigeration systems.

Lennox, AHRI, Keeprite, National Refrigeration, and Hussmann commented in response to the June 2021 RFI, that adopting the changes to AHRI 1250–2020 in the DOE test procedure would result in different energy consumption measurements. (Lennox, No. 9 at p. 2; AHRI, No. 11 at p. 4; Keeprite, No. 12 at p. 1; National Refrigeration, No 17 at p. 1; Hussmann, No. 18 at p. 6) DOE has tentatively determined that certain changes in AHRI 1250–2020, if adopted in DOE's test procedure, would impact measured values as compared to the current DOE test procedure. As discussed in the following paragraphs, DOE proposes to adopt such provisions in the newly proposed appendix C1 through refence to AHRI 1250–2020 and proposes that appendix C1 would not be required for testing until such time as compliance is required with amended energy conservation standards for walk-ins that are based on testing according to appendix C1, should DOE adopt such standards.

The test procedure changes that DOE proposes to include in a newly proposed appendix C1 are discussed in the following sections. DOE expects these changes to improve the representativeness and applicability of the test procedure for walk-in refrigeration systems.

1. Off-Cycle Power Consumption

For walk-in refrigeration systems, the term off-cycle refers to the period when the compressor is not running and defrost (if applicable) is not active. During off-cycle, unit cooler fans and other auxiliary equipment (*i.e.,* crankcase heater, receiver heater, etc.)[38] may typically run or cycle on and off, consuming energy. The DOE test procedure currently accounts for only unit cooler fan energy use during the off-cycle period. 10 CFR part 431, subpart R, appendix C, section 3.3.3. Specifically, the current test procedure requires manufacturers to measure the integrated average off-cycle fan wattage[39] for matched pair and unit coolers tested alone. Dedicated condensing units tested alone use default fan energy values rather than tested values. 10 CFR part 431, subpart R, appendix C, section 3.4.2.2. When calculating AWEF, the unit cooler fans are assumed to run at this average integrated wattage throughout the entire off-cycle duration. *Id.*

In the June 2021 RFI, DOE discussed the recommendations of the ASRAC Working Group (*See* Docket No. EERE–2015–BT–STD–0016, No. 56,[40] Recommendation #6) to revise the off-cycle test procedure to account for all other components that consume energy during the off-cycle, such as pan heaters, crankcase heaters, and controls. 86 FR 32332, 32348. DOE noted that AHRI 1250–2020 includes a method for determining energy consumption during

as unit cooler exit dew point temperature), and 6.5 °F superheat (in case the installation manual doesn't provide superheat requirements). Thus, the unit cooler exit temperature would be 25 °F + 6.5 °F = 31.5 °F, and the implied suction line temperature rise is 41 °F − 31.5 °F = 9.5 °F. The analysis conducted for wine cellars rounds this to 10 °F.

[37] ''Head pressure control'' refers to the reduction of condenser heat transfer performance using fan cycling or other means when it is cold outside in order to avoid unusually low condensing temperature. Such low condensing temperatures are undesirable because they can reduce refrigeration system performance and/or increase risk of compressor damage. A typical minimum condensing temperature is 70 °F, which may apply whenever outdoor temperature is lower than 50 °F. DOE selected the 90 °F annual average to be representative of operation that would involve condensing temperature ranging from 70 °F to 120 °F, since outdoor temperature varies.

[38] A crankcase heater prevents refrigerant migration and mixing with the crankcase oil when the compressor is off by heating the crankcase of the compressor. A receiver heater warms refrigerant in the receiver to prevent flooded starts of the compressor and cycling on low pressure to reduce the potential for compressor damage. They are used for outdoor dedicated condensing units in colder climates.

[39] Fans using periodic stir cycles are tested at the greater of a 50% duty cycle or the manufacturer default. Fans with two, multi-, or adjustable-speed controls are tested at the greater of 50% fan speed or the manufacturer's default fan speed. Fans with no controls are tested at their single operating point. (*See* 10 CFR part 431, subpart R, appendix C, section 3.3.3).

[40] Appliance Standards and Rulemaking Federal Advisory Committee Refrigeration Systems Walk-in Coolers and Freezers Term Sheet, available at *www.regulations.gov/document?D=EERE-2015-BT-STD-0016-0056.*

off-cycle for many of these components and DOE discussed the possibility of incorporating the updated industry test method into a test procedure. In response to the June 2021 RFI, the CA IOUs supported the prioritization of ASRAC Term Sheet recommendation #6. (CA IOUs, No. 14 at p. 1–2)

DOE requested comment on the representativeness and repeatability of the off-cycle test procedure in AHRI 1250–2020. 86 FR 32332, 32348. Keeprite and National Refrigeration both stated that the off-cycle power measurement in AHRI 1250–2020 is accurate. (Keeprite, No. 12 at p. 2; National Refrigeration, No. 17 at p. 2) Lennox, AHRI, ASAP, and Hussmann supported using the off-cycle power measurements in AHRI 1250–2020. (Lennox, No. 9 at p. 9; AHRI, No. 11 at p. 14; ASAP, No. 13 at p. 2; Hussmann, No. 18 at p. 17) Keeprite and National Refrigeration asserted that adopting the off-cycle power measurements in AHRI 1250–2020 would increase test burden without significant efficiency gains. (Keeprite, No. 12 at p. 3; National Refrigeration, No 17 at p. 2) NEEA commented that AHRI 1250–2020 captures off cycle energy consumption more fully but does not appear to account for start up or shutdown variation. (NEEA, No. 16 at p. 2)

Also, in the June 2021 RFI, DOE sought feedback on whether there were additional walk-in refrigeration system components that consume energy while the unit is in off-cycle mode, which AHRI 1250–2020 does not address. 86 FR 32332, 32348. DOE did not receive comments on this topic.

In the June 2021 RFI, DOE additionally requested comment on the magnitude of off-cycle energy use for each component. *Id.* DOE did not receive comments on this topic.

DOE acknowledges that adopting the off-cycle power measurements in AHRI 1250–2020 may incrementally increase test time; however, obtaining off-cycle power measurements would account for less than 10 percent of the overall setup and test duration for walk-in refrigeration systems. In its testing, DOE has found that the additional energy use measured using the off-cycle power measurements in AHRI 1250–2020 can be up to 60% more than the off-cycle power measurements in the current test procedure, indicating that the current test procedure does not fully represent off-cycle power use for walk-in refrigeration systems. Therefore, DOE proposes adopting the off-cycle procedure in sections C3.5, C4.2, and Table C3 in AHRI 1250–2020.

In the following sections (III.F.1.a through III.F.1.d), DOE presents in more detail its proposals to modify the off-cycle test method and metric.

a. Off-Cycle Test Duration and Repetition

DOE proposes revising the off-cycle test procedure to account for all other components (beyond evaporator fans) that consume energy during the off-cycle, including, but not limited to pan heaters, crankcase heaters, and controls (collectively, ''ancillary equipment''). To account for this energy, DOE proposes adopting the off-cycle power measurements in sections C3.5, C4.2, and Table C3 in AHRI 1250–2020. This method is generally consistent with the current DOE test method used to account for off-cycle evaporator fan power; however, DOE proposes adopting AHRI 1250–2020 in order to properly account for the energy use of ancillary equipment.

Specifically, AHRI 1250–2020 includes two off-cycle test durations: One for evaporator fans and ancillary equipment with controls that are time-varying or respond to ambient or refrigerant temperatures (*e.g.,* a crankcase heater or fan cycling control), and one for evaporator fans and ancillary equipment without such controls. For the former, AHRI 1250–2020 requires a 30-minute test. DOE expects that 30 minutes is the shortest duration that can effectively capture the cyclic and time-varying energy use that may occur for equipment with controls—thus, this duration balances the need to minimize test burden with the need for an accurate and representative test method. For units lacking such controls, AHRI 1250–2020 requires a test cycle duration of 5 minutes. In the absence of controls, DOE expects the off-cycle integrated power to be constant over time; consequently, DOE is proposing the shorter 5-minute duration, which would minimize test burden, while still providing results representative of off-mode energy consumption.

AHRI 1250–2020 also has two sets of test repetition requirements: One for evaporator fans and ancillary equipment with controls that are time-varying or respond to ambient or refrigerant temperatures (*e.g.,* a crankcase heater or fan cycling control), and one for evaporator fans and ancillary equipment without such controls. For the former, AHRI 1250–2020 requires that the off-cycle test for each applicable load point[41] would consist of three initial test cycles, with the potential for three supplemental cycles. DOE anticipates that at least three cycles are needed to determine if the measured integrated off-cycle power is representative of typical operation because the cyclic operation of evaporator fan and ancillary equipment controls has the potential to introduce a significant level of test-to-test variability. Specifically, AHRI 1250–2020 states that if the integrated power for each of the first three cycles is within 2 percent of the average of the first three cycles, then off-cycle power would be calculated as the average of the first three cycles. This requirement reduces test burden if the unit under test shows repeatable performance. If the 2 percent requirement is not met, DOE proposes running three supplemental cycles to provide an opportunity for the unit's controls to exhibit repeatable behavior. Specifically, AHRI 1250–2020 states that if the integrated power for each of the three supplemental cycles is within 2 percent of the average of the three supplemental cycles, then off-cycle power would be calculated as the average of the three supplemental cycles—this follows the same rationale as the three initial test cycles. DOE expects that continuing to test the unit beyond a total of six cycles would be ineffectual and overly burdensome, as the previous two rounds of testing would show that stable test-to-test integrated power readings are unlikely. In the absence of stability, AHRI 1250–2020 requires off-cycle power to be calculated as the maximum of all six integrated power readings. This requirement is appropriate since it provides a conservative estimate of integrated off-cycle.

Alternatively, for equipment lacking evaporator fans and ancillary equipment controls, AHRI 1250–2020 requires a single cycle to measure integrated power. In the absence of controls, DOE expects the off-cycle integrated power to be constant from cycle-to-cycle; consequently, DOE is proposing the single-cycle test for units without ancillary power controls. DOE has preliminarily determined that this approach would minimize test burden, while providing results representative of off-mode energy consumption. A summary of test durations and fan settings based on fan control configuration and ancillary equipment control configuration is listed in Table III.8.

[41] Off-cycle load points are discussed later in this section.

TABLE III.8—PROPOSED OFF-CYCLE TEST SETTINGS AND DURATIONS

Fan control configuration	Ancillary equipment control configuration	Fan setting for test	Test duration
No Control	No Control	Default setting, as shipped	5 minutes.
No Control	With Control	Default setting, as shipped	30 minutes.
User-Adjustable Speed Controls.	No Control	The greater of 50% fan speed or the manufacturer's default fan speed.	5 minutes.
User-Adjustable Speed Controls.	With Control	The greater of 50% fan speed or the manufacturer's default fan speed.	30 minutes.
User-Adjustable Stir Cycles	With or Without Control	The greater of a 50% duty cycle or the manufacturer default.	The greater of 30 minutes or three full "stir cycles."
Non-User Adjustable Controls	With or Without Control	Default setting, as shipped	30 minutes.

b. Off-Cycle Operating Tolerances and Data Collection Rates

DOE proposes to adopt the off-cycle power measurements in Section C3.5 of AHRI 1250–2020 to establish off-cycle-specific operating test tolerances. AHRI 1250–2020 excludes the first 10 minutes that follow the termination of the compressor on-cycle interval from the general operating tolerances (indoor/outdoor temperatures and power readings) established for the on-cycle steady state test. During this time period, the test room conditioning equipment is transitioning from steady state on-cycle operation into off-cycle operation and the evaporator coil will continue to remove heat from the inside room air until temperature equilibrium between the coil and the air is reached. This non-steady state operation following the on-cycle creates an environment that is temporarily difficult to control; consequently, DOE expects that the suspension of steady state tolerances during the transition period would not impact the representativeness of the test, since this non-steady state operation is representative of real-world performance during the transition period.

DOE also proposes to establish off-cycle-specific data collection rates by adopting the off-cycle power measurements approach provided in Section C3.6 of AHRI 1250–2020. Specifically, AHRI 1250–2020 requires that the minimum data collection rate be increased (with respect to steady-state requirements) from 30 to 60 test readings per hour for temperature measurements and condensing unit electric power measurements, and from 3 to 60 test readings per hour for unit cooler electric power measurements. *See* Table C3 in Section C3.6.2 of AHRI 1250–2020. DOE anticipates that the increased data collection rate is necessary since the off-cycle test time interval can be as low as five minutes whereas the steady-state test will typically run for at least 60 minutes. AHRI 1250–2020 also requires that off-cycle power measurements be integrated and averaged over the recording interval with a sampling rate of no less than 1 second unless an integrating watt/hour meter is used. This requirement is necessary since power is anticipated to fluctuate during the off-cycle test. Increasing to a 1 second sampling rate allows for an accurate software integration of power that would be comparable to an integrating watt/hour meter.

c. Off-Cycle Load Points

Currently, the DOE test procedure specifies that off-cycle evaporator fan power is measured once with no specifications for ambient conditions. The current test procedure uses this approach because off-cycle fan power is not expected to vary significantly with ambient conditions. However, DOE expects the integrated power of ancillary equipment to potentially vary with ambient conditions, depending on the refrigeration system design. Consequently, DOE proposes that the off-cycle power test described in section III.G.1.a be run at each steady-state ambient test conditions as specified in Tables 4 through 17 of AHRI 1250–2020. Accordingly, refrigeration systems with dedicated condensing units located indoors would evaluate off-cycle power at a single outdoor ambient condition (90 °F dry-bulb), while systems with dedicated condensing units located outdoors would determine off-cycle power at three ambient conditions (95 °F, 59 °F, and 35 °F dry-bulb). The measured integrated off-cycle power results would then be used to calculate a revised AWEF metric, as described in the following section.

d. Modification to AWEF Calculations

Walk-in cooler AWEF is calculated as a function of steady state capacity, steady state on-cycle power, and off-cycle unit cooler fan power in the current test procedure (see Section 7 of AHRI 1250–2009). 10 CFR part 431, subpart R, appendix C, sections 3.3 and 3.4. AWEF for walk-in freezers considers defrost electrical energy consumption in addition to steady state gross capacity, steady state on-cycle power, and off-cycle fan power. *Id.* As discussed earlier, DOE proposes to update the AWEF calculation for refrigeration systems to account for off-cycle power more fully, not just off-cycle evaporator fan power. To do so, DOE proposes adopting the off-cycle calculations in AHRI 1250–2020, which replace integrated off-cycle evaporator fan power with the combined integrated off-cycle power from the unit cooler and condensing unit in each equation. Additionally, for unit coolers tested alone, DOE proposes to update the AWEF calculation to account for all unit cooler off-cycle power—not just the evaporator fan power.[42] To do so, DOE proposes adopting the off-cycle calculations in AHRI 1250–2020, which replace integrated off-cycle fan power with integrated off-cycle power in the unit cooler equation.

DOE, however, proposes deviating from the AHRI 1250–2020 calculations for off-cycle energy use for outdoor refrigeration systems. DOE notes that the AHRI 1250–2020 equations for average refrigeration system total power input for bin temperature T_j, *e.g.,* Equation 13, do not appear to use off-cycle power values for the unit cooler and/or the condensing unit that vary with T_j. In fact, there are no equations providing the off-cycle power for either component as a function of T_j in Section 7 of AHRI 1250–2020, such as there are for net capacity and on-cycle power input (*e.g.,* Equations 14 through 17). Since the off-cycle power may vary as a function of outdoor temperature as discussed previously, DOE proposes to

[42] DOE notes that under this proposal, condensing unit off-cycle power is not explicitly accounted for unit coolers; rather, the total energy contribution from the condensing unit is based on a defined EER lookup table, which is currently found in Table 17 of AHRI 1250–2009 (incorporated by reference, 10 CFR 431.303(b)). This NOPR proposes changing that to Table 18 of AHRI 1250–2020. This aspect of the proposed unit cooler test method is consistent with the current method specified in appendix C to subpart R of 10 CFR part 431.

provide instructions for calculating off-cycle power as a function of outdoor temperature based on the measurements made at the three outdoor test condition temperatures.

For condensing unit off-cycle power, DOE proposes to require that off-cycle power for T_j less than or equal to 35 °F would be equal to the power measured for the test condition C off-cycle power test. For T_j higher than 95 °F, DOE proposes that off-cycle power would be equal to the power measured for the test condition A off-cycle power test. Between these two temperatures, DOE proposes that condensing unit off-cycle power would be determined based on the test condition B and C measurements when T_j is below 59 °F, and based on the A and B measurements when it is above 59 °F, similar to equations 14 through 17 for on-cycle capacity and power.

For unit cooler off-cycle power, it is unclear whether to apply a specific trend correlated to condensing unit outdoor air temperature. DOE notes that AHRI 1250–2020 did not establish tests for unit coolers tested alone for different condensing unit outdoor air temperatures, which supports the suggestion that there is no such trend. Hence, DOE is not proposing any equations for unit cooler off-cycle power that are based on the different bin temperatures, T_j. Instead, DOE proposes that the three-unit cooler off-cycle power measurements that would be made when testing a matched pair or single-packaged dedicated system would be averaged, and that the resulting average, with no dependence on T_j, would be used in the AWEF calculations.

Issue 19: DOE requests comments on its proposals to align the test procedures for appendix C1 with AHRI 1250–2020, except for the use of off-cycle power measurements in the AWEF calculations for dedicated condensing units, matched pairs, or single-packaged dedicated systems intended for outdoor installation. DOE requests comments on its proposals for use in the AWEF calculations of the three sets of unit cooler and condensing unit off-cycle measurements made for outdoor refrigeration systems.

2. Single-Packaged Dedicated Systems

a. AHRI 1250–2020 Methods for Testing

As discussed in section III.B.3.c, AHRI 1250–2020 expanded methods of test for single-packaged units to include air enthalpy, calorimetry, and compressor calibration. Specifically, AHRI 1250–2020 incorporates the following tests procedures by reference:

(1) Air enthalpy method: ASHRAE 37 and ANSI/ASHRAE 41.6–2014 (''ASHRAE 41.6''), ''Standard Method for Humidity Measurement'';

(2) calorimeter methods: ASHRAE 16, ''Method of Testing for Rating Room Air Conditioners, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps for Cooling and Heating Capacity'';

(3) compressor calibration methods: ASHRAE 37 and ANSI/ASHRAE 23.1–2010.

AHRI 1250–2020 requires two simultaneous measurements of system capacity (*i.e.,* a primary and a secondary method) for single-packaged dedicated systems, and Section C9.2.1 of AHRI 1250–2020 requires that the measurements agree within 6 percent. Table C4 in AHRI 1250–2020 specifies which of the test methods (calorimeter, air enthalpy, and compressor calibration) qualify as primary and/or secondary methods. However, as summarized in Table III.9, DOE is proposing to modify the method of test and test hierarchy table in AHRI 1250–2020 to include a single-packaged refrigerant enthalpy method—the addition of the Single-Packaged Refrigerant Enthalpy method is the only change to the hierarchy of test methods that DOE is proposing. The reasoning behind this addition is discussed in section III.G.2.d of this document.

TABLE III.9—SINGLE-PACKAGED SYSTEM TEST METHODS AND TEST HIERARCHY

Method of test	Allowable use
Balanced Ambient Indoor Calorimeter	Primary.
Balanced Ambient Outdoor Calorimeter	Primary or Secondary.
Indoor Air Enthalpy	Primary or Secondary.
Indoor Room Calorimeter	Primary or Secondary.
Single-packaged Refrigerant Enthalpy [43]	Secondary.
Outdoor Room Calorimeter	Secondary.
Outdoor Air Enthalpy	Secondary.
Compressor Calibration	Secondary.

b. Waivers

DOE granted a waiver to Store It Cold for single-packaged units on August 9, 2019. 84 FR 39286. Store It Cold petitioned for a waiver after determining that the refrigerant enthalpy method specified in AHRI 1250–2009 was not providing consistent capacity measurements for its single-packaged dedicated systems. 84 FR 39286, 39287. The alternate test procedure associated with this waiver requires that the specified single-packaged basic models shall be tested using the Indoor Air Enthalpy Method and the Outdoor Air Enthalpy Method in accordance with ASHRAE 37. 84 FR 39286, 39292. DOE also granted waivers to Air Innovations, CellarPro, Vinotemp, and Vinotheque for walk-in refrigeration systems used in wine cellar applications, where some of the basic models included in these waivers were single-packaged dedicated systems.[44] Similar to the Store It Cold waiver, the alternate test methods included in these other waivers require the specified basic models to be tested in accordance with the air enthalpy methods specified in ASHRAE 37 for testing single-packaged dedicated systems, which is now referenced by AHRI 1250–2020. Use of air enthalpy methods for testing a single-packaged dedicated system captures the impact of thermal loss and the infiltration of warm air into the evaporator portion of these systems. As discussed, DOE proposes to reference in appendix C1 the methods of test for single-packaged dedicated systems in Section C9 of AHRI 1250–2020, with some modifications. Since DOE is proposing that appendix C1 would be required on the compliance date of any amended energy conservation standards, were such standards to be adopted, the current test procedure waivers for specified single-packaged basic models would expire on the compliance date of proposed appendix C1 if it should be adopted.

[43] As described in section III.G.2.f, this does not apply to CO_2 single-packaged units.

[44] Table III.2 lists the manufacturers that have received a test procedure waiver or interim waiver for walk-in refrigeration systems designed for wine cellar applications.

c. Suitability of the Single-Packaged Test Methods in AHRI 1250–2020

In the June 2021 RFI, DOE requested data or comment on the additional thermal losses associated with single-packaged dedicated systems, and whether AHRI 1250–2020 fully accounts for these losses. 86 FR 32332, 32344. Lennox, AHRI, and Hussmann stated that the AHRI 1250–2020 single-packaged formulas account for additional thermal losses. (Lennox, No. 9 at p. 5; AHRI, No. 11 at p. 10; Hussmann, No. 18 at p. 12) These stakeholders also asserted that the calorimeter test method should measure any minimal leakage. *Id.*

In response to the June 2021 RFI, the CA IOUs commented that the room calorimeter and air enthalpy test methods in AHRI 1250–2020 would address single-packaged dedicated system test challenges that led to the Store It Cold waiver petition and subsequent granting of the waiver. (CA IOUs, No. 14 at p. 2) However, the comment did not specifically address the single-packaged heat loss or its magnitude.

DOE requested comment on the representativeness of the single-packaged dedicated test and calculation methods in AHRI 1250–2020 in the June 2021 RFI. DOE additionally invited comment on whether DOE should update its test procedure to incorporate AHRI 1250–2020 by reference. 86 FR 32332, 32343–32344. While Lennox, AHRI, and Hussmann each supported the AHRI 1250–2020 test methods for single-packaged dedicated systems, these stakeholders stated that these test procedures have not yet been fully evaluated and recommended against DOE updating its test procedure to incorporate single-packaged system-specific sections of AHRI 1250–2020. (Lennox, No. 9 at p. 5; AHRI, No. 11 at p. 9; Hussmann, No. 18 at p. 12)

The calorimeter tests mentioned previously were originally developed in ASHRAE 16 for testing room air conditioning units. In the June 2021 RFI, DOE noted that precise determination of the calorimeter chamber cooling fluid heat capacity is necessary for an accurate test. 86 FR 32332, 32344. Since air conditioning units do not cool below 32 °F, the freezing temperature of pure water, ASHRAE 16 would not have encountered problems with this issue, as water can be used as the calorimetry fluid and the heat capacity of pure water is known. When testing walk-in refrigeration systems using this method, the fluid may have to be at a temperature lower than 32 °F, which means that pure water would not be used. Precise determination of the heat capacity of glycol-water mixtures may present a challenge, since the concentration of the mixture must be determined. Therefore, in the June 2021 RFI, DOE requested feedback on what heat transfer liquids might be used to maintain test chamber temperature when testing single-packaged dedicated systems using the calorimeter method included in AHRI 1250–2020. DOE additionally requested comment on whether the calorimetric procedure in AHRI 1250–2020 for testing single-packaged dedicated systems could be modified to enhance test accuracy or repeatability. 86 FR 32332, 32344. Lennox, AHRI, and Hussmann stated that additional testing is necessary to fully evaluate each test method outlined for single-packaged units in AHRI 1250–2020. (Lennox, No. 9 at p. 5; AHRI, No. 11 at p. 10; Hussmann, No. 18 at p. 12) Daikin commented that standard EN 17432 uses a room calorimetry test for single-packaged units, with test conditions and a setup figure provided in the comment. (Daikin, No. 17 at p. 3) DOE notes the calorimetry room method suggested by Daikin does not appear to have a glycol loop and therefore does not provide a solution for heat transfer liquids that could be used when testing single-packaged dedicated systems using the calorimeter method included in AHRI 1250–2020. After consideration, DOE has tentatively determined that the comments provided do not conclusively indicate one way or the other that the AHSRAE 16 test method is unsuitable for walk-in refrigeration systems. Therefore, DOE is proposing to adopt the ASHRAE 16 calorimetry methods of test for single-packaged dedicated systems as referenced in AHRI 1250–2020. This approach would provide flexibility in selecting from one of the discussed testing methods even if these methods may be more challenging to implement for walk-in refrigeration systems than for room air conditioners. As the comments have not provided sufficient quantitative information, DOE will continue to consider this question and may take action at a later date.

DOE also discussed the requirement for a pressure equalizer device for calorimetry chambers in ASHRAE 16 in the June 2021 RFI. DOE noted that since the calibrated box method (established in the current DOE test procedure) does not require such a device, this may increase testing burden. 86 FR 32332, 32344. DOE discussed two potential alternatives to this requirement; specifically, (1) no requirement to address transfer air or pressure equalization, or (2) require leak-free test facility chambers with no equalization requirement. *Id.* DOE requested comment on the requirement for a pressure equalizing device in ASHRAE 16 and solicited feedback on the expected cost and resource burdens associated with employing such a device. *Id.* Lennox, AHRI, and Hussmann stated that an equalizer device would not be necessary if the chamber were leak-free, that the addition of an equalizer device has not been fully evaluated and is expected to increase test burden. (Lennox, No. 9 at p. 5; AHRI, No. 11 at p. 10; Hussmann, No. 18 at p. 13) Based on the single-packaged system testing conducted by DOE, DOE is not planning to propose an equalizer device for calorimeter room testing. DOE notes that a pressure equalizer is typically used when comfort cooling devices have a damper to bring fresh air into the cooled environment. Single-packaged dedicated systems do not include this functionality and therefore a pressure equalizing device is not necessary.

Finally, DOE requested comment on any alternative test methods to measure single-packaged dedicated system capacity in the June 2021 RFI. 86 FR 32332, 32344. Lennox, AHRI, and Hussmann confirmed that the test methods included in AHRI 1250–2020 for testing single-packaged dedicated systems are sufficient. (Lennox, No. 9 at p. 6; AHRI, No. 11 at p. 10; Hussmann, No. 18 at p. 13)

Testing conducted by DOE on single-packaged units using the room calorimeter and air enthalpy methods as described in AHRI 1250–2020 suggest that these test methods appropriately account for the thermal losses experienced by this equipment. Therefore, DOE has tentatively determined that these methods are representative of single-packaged system energy use. As such, DOE proposes to adopt the single-packaged system test procedure in AHRI 1250–2020 with the modifications outlined in sections III.G.2.d and III.G.2.e of this document. DOE notes that while there may not be extensive experience applying these test methods to walk-in refrigeration systems, all the proposed test methods have been evaluated and are used extensively for testing other HVAC equipment. Additionally, DOE is required, as soon as practicable after the granting of any waiver, to publish in the **Federal Register** a notice of proposed rulemaking to amend its regulations so as to eliminate any need for the continuation of such a waiver. 10 CFR 431.401(l). Finally, DOE emphasizes that testing according to proposed appendix C1 would not be required until such time as compliance is required with any amended energy conservation standards, should such standards be adopted. As such, were appendix C1 adopted, the existing waivers would remain in effect until such time as compliance would be required with appendix C1.

d. Single-Packaged Refrigerant Enthalpy Method

As previously discussed, AHRI 1250–2020 includes 4 potential primary, and 6 potential secondary test methods for testing single-packaged dedicated systems (see Table III.9). The refrigerant enthalpy method is not included in this list. Although the dual instrumentation test (*i.e.,* two separate measurements using the refrigerant enthalpy method) is routinely used to evaluate the capacity of matched pair, dedicated condensing, and unit cooler systems, the DX dual instrumentation method is generally considered to be impractical for testing single-packaged dedicated systems. This is primarily because it requires breaking into the liquid refrigerant line within the packaged unit, routing the line outside of the unit to pass through two mass flow meters, and then routing the line back into the unit and through dual pressure and temperature measurements before it rejoins the original liquid line at the expansion device inlet. This is generally inappropriate for a single-packaged unit because the internal volume of the added liquid line and mass flow meters adds substantially to the required refrigerant charge, and the entire assembly adds substantial pressure drop.[45] As discussed in section III.A.2.e, RSG submitted a request for waiver and interim waiver to use the refrigerant enthalpy method to test single-packaged dedicated systems with multiple refrigeration circuits, using only one mass flow meter per circuit and using added refrigerant liquid line no longer than 5 feet in length.[46] DOE is proposing to adopt a single-packaged refrigerant enthalpy method that is similar to the alternate test procedure outlined in RSG's waiver request.

The single-packaged refrigerant enthalpy method would be based using the refrigerant-side measurements of the DX Calibrated Box method in section C8 of AHRI 1250–2020 while simultaneously using one of the ''Primary'' methods listed in the table for single-packaged methods of test as an air-side measurement. These primary test methods all measure the capacity delivered to the air passing through the evaporator section of the system, or to the air that is refrigerated by the system. Before disassembling the refrigeration system to set up the refrigerant-side mass flow measurement, a preliminary test at Condition A would be conducted using only the primary air-side measurement. For this test, surface-mounted temperature sensors would be installed on the evaporator and condenser coils, tubing entering and leaving the compressor, and tubing entering the expansion device. This preliminary test would be compared to the later test at Condition A using both airside and refrigerant-side measurements. To ensure that the refrigerant circuit modifications did not materially alter the system operation, the later test would be performed to confirm that (1) each on-coil temperature sensor indicates a reading that is within ±1.0 °F of its initial-test measurement, (2) the temperatures of the refrigerant entering and leaving the compressor are within ±4 °F, and (3) the refrigerant temperature entering the expansion device is within ±1 °F. To limit the alteration of the refrigerant circuit, only 5 feet of tubing shall be added to the liquid refrigerant lines (not including the flow length associated with the mass flow meter).

The heat balance applied to single-packaged dedicated systems using this method would involve comparison of the air-side net capacity to a net capacity determined based on the gross refrigerant-side capacity measurement that would include adjustment for the evaporator fan heat in addition to adjustment for the single-packaged dedicated system thermal loss. The thermal loss would be calculated similarly to the duct loss calculation of Section 7.3.3.3 of ASHRAE 37–2009, in which the heat losses associated with the insulated surface areas subject to heat transfer are summed based on their surface area, thermal resistance (which is based on known insulating material and insulation thickness), and the temperatures on either side of the surface.

Issue 20: DOE requests comment on the proposed single-packaged refrigerant enthalpy test procedure for evaluating the performance of single-packaged dedicated systems.

e. Multi-Circuit Single-Packaged Dedicated Systems

Multi-circuit single-packaged refrigeration systems provide a solution for flammable refrigerants, where safety standards limit the amount of refrigerant in a refrigeration circuit. Some flammable refrigerants, like propane, are efficient and have a very low global warming potential (''GWP''),[47] making them advantageous design options for future refrigeration systems. Neither the current DOE test procedure nor AHRI 1250–2020, which DOE is proposing generally to adopt through reference in its updated test procedure for walk-in refrigeration systems, provides a method for testing single-packaged dedicated systems with multiple refrigeration circuits.

In its request for waiver and interim waiver, RSG provided an alternate test method for testing multi-circuit single-packaged dedicated systems. (EERE–2022–BT–WAV–0010–0001) This test procedure is based on the single-packaged refrigerant enthalpy method for single-packaged units described in section III.G.2.d of this document. The procedure is duplicated for each refrigeration circuit contained in the unit such that each circuit returns mass flow, enthalpy in, and enthalpy out values. The resultant mass flow and enthalpy values are used to calculate the gross refrigeration capacity for each circuit. Each circuit's gross capacity is then summed to determine the total capacity of the system.

DOE has tentatively determined that the alternate approach would generally provide a reasonable method for determining the capacity of multi-circuit single-packaged dedicated systems. However, this approach may not adequately capture the heat loss associated with single-packaged dedicated systems; therefore, an indoor air refrigeration capacity test would need to be used to confirm the multiple refrigeration circuit capacity test. In sum, DOE proposes to adopt the previously described method for determining the capacity of single-packaged dedicated systems with multiple refrigeration circuits, with the additional requirement that the primary test would be an indoor air refrigeration capacity test where the allowable refrigeration capacity heat balance is 6 percent.

[45] These issues were the primary motivation for and are described in the Store-it-Cold petition for waiver—see the discussion in section III.G.2.b of this document.

[46] The RSG petition for waiver and interim waiver can be found at *www.regulations.gov/docket/EERE-2022-BT-WAV-0010.*

[47] Global warming potential is a measure of a substance's ability to warm the planet relative to CO_2. CO_2 has a GWP of 1 while a traditional HFC refrigerant like R134a has a GWP of 3400, meaning a ton of R134a warms the planet 3400 times more than a ton of CO_2.

In summary, DOE is proposing to adopt the test procedures in section C8 of AHRI 1250–2020 for testing single-packaged dedicated systems with modifications to allow for secondary refrigerant enthalpy tests, and to accommodate multi-circuit single-packaged dedicated systems. The proposed test methods and their designation as primary or secondary tests are outlined in Table III.9 of this document.

f. CO_2 Single-Packaged Dedicated Systems

The current DOE test procedure for single-packaged dedicated systems uses dual instrumentation refrigerant enthalpy methods. Using these methods, the current test procedure does not provide representative values for single-packaged dedicated systems that use CO_2 as a refrigerant because CO_2 remains in a gaseous state in those areas where mass flow meters are placed. The typical mass flow meters do not deliver accurate readings unless the medium being measured is in liquid form. However, the single-packaged dedicated system test methods in AHRI 1250–2020 use air enthalpy measurements and would not require any refrigerant mass flow measurements. This means single-packaged refrigeration systems that use CO_2 as a refrigerant can be tested using these methods with no issues. Therefore, DOE proposes that single-packaged refrigeration systems that use CO_2 as a refrigerant be tested using the test methods for single-packaged dedicated systems outlined in AHRI 1250–2020.

3. Detachable Single-Packaged Dedicated Systems

As discussed in section III.A.2.g DOE is aware of refrigeration systems that are installed with the evaporator unit through the wall of the walk-in, but with the condensing unit installed remotely and connected to the evaporator with refrigerant lines—DOE has defined this equipment as ''detachable single-packaged dedicated systems.'' Neither subpart R, appendix C, nor AHRI 1250–2020 contain provisions for testing these walk-in refrigeration systems. Detachable single-packaged dedicated systems may be tested as either systems with the condensing unit and unit cooler in separate housings or as single-packaged dedicated systems. Testing as the former is more typical of the walk-in industry and therefore may be less burdensome. However, testing as a single-packaged system using the indoor air enthalpy test would account for the heat loss of the evaporator installation. Since the single-packaged indoor air enthalpy method would be more representative of these separable single-packaged dedicated systems, DOE is proposing as part of new appendix C1 and 10 CFR 429.53(a)(2)(i)(C) that detachable single-packaged dedicated systems would be tested using the test procedure for single-packaged dedicated systems.

Issue 21: DOE requests comment on testing detachable single-packaged dedicated systems using the test procedure for single-packaged dedicated systems.

4. Attached Split Systems

As discussed in section III.A.2.f., DOE is aware of refrigeration systems that are sold as matched systems and permanently attached to each other with beams. These systems are mounted to the cooler box with the beams piercing the interior wall of the walk-in. As discussed in section III.A.2.f, DOE is proposing to classify these systems as ''attached split systems.'' While thermal losses are expected to be lower for an attached split system than a single-packaged system since attached split systems have comparatively more insulation between the condenser and evaporator sides, DOE has preliminarily confirmed through testing that these systems still experience some heat leakage when compared to traditionally-installed systems that have the dedicated condensing unit and the unit cooler in separate housings. However, this heat leakage has not been studied extensively and DOE is aware that it may be difficult to calculate. Because of this issue, DOE is proposing in new appendix C1 and 10 CFR 429.53(a)(2)(i)(D) that attached split systems would be tested as a matched pair using refrigerant enthalpy methods.

Issue 22: DOE requests comment on its proposal that attached split systems be tested using refrigerant enthalpy methods.

5. Systems for High-Temperature Freezer Applications

As discussed in the December 2016 final rule, stakeholders commented that high-temperature freezer walk-ins, which have an enclosed storage (*i.e.,* room) temperature range of 10 °F to 32 °F, are typically refrigerated with medium-temperature dedicated condensing units. 81 FR 95758, 95790. Under the statutory definitions of ''walk-in cooler'' and ''walk-in freezer,'' this equipment would be considered a walk-in freezer because its room temperature is less than or equal to 32 °F. (42 U.S.C. 6311(20))

Accordingly, these refrigeration systems would be tested using a room temperature of −10 °F, as specified in subpart R, appendix C. However, stakeholders commented that it is difficult for these medium-temperature refrigeration systems to meet this temperature condition when using lower GWP refrigerants.[48] 81 FR 95758, 95790. Lennox offered data suggesting that medium-temperature units generally perform more efficiently at the 10 °F operating condition (*i.e.,* the low end of the cited ''high-temperature freezer'' temperature range) than low-temperature systems. (Docket EERE–2015–BT–STD–0016, Lennox, No. 89[49] at pp. 2–5) Lennox suggested that this ''high-temperature freezer'' application may justifiably represent a third class of walk-in refrigeration systems, but also noted the reporting and testing burden that establishing an additional set of classes would incur. *Id.* In response, DOE noted that manufacturers of equipment that cannot be tested in a way that properly represents their performance characteristics may petition DOE for a test procedure waiver, as detailed in 10 CFR 431.401. DOE also indicated that it may consider amending its regulations by establishing new equipment classes and applicable test methods. 81 FR 95758, 95791.

In the June 2021 RFI, DOE presented three potential approaches for testing and certifying high-temperature freezers. One approach would provide for testing and certification based on the standardized 35 °F walk-in cooler temperature (or corresponding refrigerant suction conditions), if the walk-in refrigeration system is marketed at or above 10 °F. By extension, the approach would also allow representations of performance (*e.g.,* capacity, power input) of such medium-temperature refrigeration systems for walk-in temperatures at 10 °F and higher without requiring them to be tested and certified based on the –10 °F low-temperature walk-in test condition. 86 FR 32332, 32350.

DOE could establish new definitions for the terms ''high-temperature freezer system'' and ''medium-temperature refrigeration system,'' that implement this potential structure. For example, ''high-temperature freezer system'' could be defined as ''a refrigeration

[48] Lennox commented that the industry was moving to low-GWP refrigerants in response to the Environmental Protection Agency final rule under the Significant New Alternatives Policy (''SNAP'') program that prohibited the use of R–404A in certain retail food refrigeration applications, including WICF refrigeration systems starting July 20, 2016. (Docket EERE–2016–BT–TP–0030, Lennox, No. 13 at p. 2) For further discussion of the SNAP rule, see section III.G.9 of this document.

[49] Available at *www.regulations.gov/document?D=EERE-2015-BT-STD-0016-0089.*

system used to cool the interior of walk-in freezers and maintain a room temperature of between 10 °F and 32 °F,'' while ''medium-temperature refrigeration system'' could be defined as ''a refrigeration system used to cool the interior of a walk-in cooler or a walk-in freezer operating above 32 °F.''

A second alternative presented in the June 2021 RFI would be to require walk-in cooler refrigeration systems to be tested and certified at their lowest application temperature conditions. 86 FR 32332, 32350. This approach would be similar to that taken for commercial refrigerators, freezers, and refrigerator-freezers, where manufacturers report the lowest application product temperature, *i.e.,* the lowest average compartment temperature at which the equipment can operate during testing (section 2.2 of appendix B to part 431, subpart C). For walk-ins, this concept could be based on the lowest evaporator return air temperature for matched pair refrigeration systems and the lowest saturated suction temperature (and a suitable corresponding return gas temperature) for dedicated condensing units tested alone. This approach would result in ratings for units used in high-temperature freezer applications that are representative of field performance, since the refrigeration system would be tested at a representative box temperature for such an application. Further, this approach would not presuppose what the optimal high-temperature freezer operating condition would be since it avoids selecting a standardized condition that may be unachievable by some units. However, AWEF ratings obtained from the lowest application temperature for different units, which would be rated for different box temperatures, would not be directly comparable. This approach would also add testing and reporting burden associated with the additional test condition.

Finally, DOE presented a third approach in the June 2021 RFI, that would establish a single standardized test condition at which walk-in cooler refrigeration equipment would be tested. 86 FR 32332, 32350. This approach would result in AWEF ratings that are not as reflective of the expected field performance as compared with the lowest application temperature approach. Under a standardized test condition approach, all walk-in cooler refrigeration systems would be rated at the same condition, providing more directly comparable ratings for models that serve similar applications.

In the June 2021 RFI, DOE requested comment on the three potential approaches for addressing high-temperature freezer walk-ins as well as any other potential approaches that DOE did not discuss. 86 FR 32332, 32350. Lennox, AHRI, Keeprite, National Refrigeration, and Hussmann supported the first option presented by DOE, specifically, testing and rating high-temperature freezer systems at 35 °F. (Lennox, No. 9 at p. 10; AHRI, No. 11 at p. 15; Keeprite, No. 12 at p. 3; National Refrigeration, No. 17 at p. 2; Hussmann, No. 18 at pp. 17–18) Keeprite and National Refrigeration both stated that this approach would eliminate the need to create a new class of equipment, and thus avoid additional testing. (Keeprite, No. 12 at p. 3; National Refrigeration, No. 17 at p. 2) Additionally, Keeprite stated that medium-temperature equipment design is no different from high-temperature freezer equipment design and therefore concluded that testing the same equipment twice would have no tangible benefit. (Keeprite, No. 12 at p. 3) ASAP and the CA IOUs recommended the third option presented by DOE, which suggested establishing new, representative test conditions for high-temperature freezers irrespective of their lowest operating temperature. (ASAP, No. 13 at p. 3; CA IOUs, No. 14 at p. 4) Specifically, the CA IOUs stated that they support establishing additional equipment classes for refrigeration systems that are not well represented by the 35 °F indoor test conditions in DOE's current test procedure. (CA IOUs, No. 14 at pp. 3–4) DOE understands the CA IOUs comment to infer that for systems not well represented by the 35 °F indoor test conditions, this equipment should be included in a separate equipment class and energy use determined at a more representative temperature, with definitions and labelling that clearly identify that these units have different test conditions than 'standard' walk-in refrigeration systems.

In the June 2021 RFI, DOE also requested information to inform the development of test procedures for high-temperature freezer systems. 86 FR 32332, 32350. Specifically, DOE sought comment on the test procedure parameters or calculations that would need to be modified to test medium-temperature refrigeration systems in the high-temperature freezer range. *Id.* Lennox, AHRI, Keeprite, National Refrigeration, and Hussmann stated that no new test procedures would be necessary if the DOE test procedure were to require testing and rating high-temperature freezers at 35 °F. (Lennox, No. 9 at pp. 10–11; AHRI, No. 11 at pp. 15–16; Keeprite, No. 12 at p. 3; National Refrigeration, No. 17 at p. 2; Hussmann, No. 18 at pp. 18–19)

As also discussed in the June 2021 RFI, if DOE were to pursue the lowest application temperature approach or the standardized high-temperature freezer test condition approach, DOE would need to establish certain new default values to calculate the AWEF and net capacity of stand-alone high-temperature freezer dedicated condensing units. 86 FR 32332, 32350. Currently, the test procedure provides equations for determining evaporator fan power, defrost energy, and defrost heat load, all of which are used in lieu of matched unit cooler test data (section 3.4.2 of subpart R, appendix C).

The current test procedure offers two separate equations that relate the cooling capacity to the evaporator fan power for medium- and low-temperature unit coolers (section 3.4.2.2 of subpart R, appendix C). Based on the condensing unit capacity at the medium-temperature test condition (35 °F box temperature), using the medium-temperature equation seems to be the most appropriate approach since the dedicated condensing units in question would also be certified as medium-temperature dedicated condensing units. This approach also assumes that fan energy use at high-temperature freezer conditions would be the same as fan energy use at medium-temperature conditions since it makes no adjustment in the calculated fan power for the high-temperature freezer application. DOE requested comment on the appropriateness of using the current medium-temperature refrigeration system default fan input power equations (found at section 3.4.2.2 of subpart R, appendix C) to represent the fan input power of high-temperature freezer refrigeration systems. 86 FR 32332, 32350. In response, Lennox, AHRI, and Hussmann recommended using the current low-temperature default fan input power equation since medium-temperature dedicated condensing units are typically paired with low-temperature unit coolers for use in high-temperature freezer applications and low-temperature unit coolers operate at higher suction temperatures than medium-temperature unit coolers. (Lennox, No. 9 at p. 11; AHRI, No. 11 at p. 16; Hussmann, No. 18 at p. 19)

In the current test procedure, defrost energy and defrost heat load for stand-alone dedicated condensing units are estimated based on the condenser capacity using an equation in section 3.4.2 of subpart R, appendix C. The calculations apply only to freezer models, since they assume that refrigeration systems serving walk-in coolers are not equipped for defrost capability and thus have no defrost energy or heat load. However, medium-temperature refrigeration systems used for high-temperature freezer applications require defrost capability because frost that collects on the evaporator during the compressor off-cycle will not melt in sub-freezing walk-in temperature conditions. The energy and heat load of these high-temperature freezer defrost systems may differ significantly from those of –10 °F freezers. Therefore, proper accounting for defrost of high-temperature freezer refrigeration systems requires developing a modified calculation. The equation found in section 3.4.2.4 of subpart R, appendix C, calculates freezer equipment daily defrost energy use (''DF'') using the condenser capacity (''$q_{mix,cd}$'') and the number of defrost cycles per day (''N_{DF}''). The daily defrost heat load (''Q_{DF}'') is directly dependent on DF (*see* relevant equation in section 3.4.2.5 of subpart R, appendix C). DOE anticipates calculating defrost impacts for high-temperature freezers, if adopted, would use similar equations with different magnitudes. In the June 2021 RFI, DOE requested information or data to inform the use of potential modifications to the defrost equations for high-temperature freezers, and whether frost loads and/or defrost frequency are different for high-temperature freezers when compared to walk-in freezers that operate at a temperature of –10 °F. 86 FR 32332, 32350. Lennox, AHRI, and Hussmann responded that modifications to defrost energy equations are unnecessary for high-temperature freezer applications since calculations for a freezer operating at –10 °F, 0 °F, and 10 °F would result in a negligible difference in defrost energy use. (Lennox, No. 9 at p. 11; AHRI, No. 11 at p. 16; Hussmann, No. 18 at pp. 19–20)

DOE recognizes that testing high-temperature freezer refrigeration systems at a consistent test condition is important to ensure test procedure consistency and to provide comparable performance values in the market. Additionally, DOE acknowledges that testing high-temperature freezer refrigeration systems at a temperature less than 35 °F would be more representative of their actual energy use; however, it is not clear if the potential additional test burden justifies including an additional test condition for walk-in cooler refrigeration systems. Therefore, DOE has tentatively determined that medium-temperature dedicated condensing units used in high-temperature freezer applications would continue to be tested according to subpart R, appendix C; however, DOE may revisit its approach for this equipment in a future rulemaking.

6. Systems for High-Temperature Applications

As discussed in the June 2021 RFI, DOE is aware of wine cellar (high-temperature) refrigeration systems that fall within the walk-in definition but that may be incapable of being tested in a manner that would yield representative performance results during a representative average use cycle under the current version of the walk-in test procedure. 86 FR 32332, 32344. For example, wine cellar refrigeration systems that may be installed in some commercial settings are designed to operate at a temperature range of 45 °F to 65 °F. Under the current walk-in test procedure, walk-in coolers must be tested while operating at 35 °F—see Section 3.1.1 of subpart R, appendix C. To the extent that a wine cellar refrigeration system does not operate at 35 °F, applying the required 35 °F testing temperature condition when evaluating the energy usage of this equipment would not produce results representative of an average use cycle.

As discussed in section III.A.2.c, DOE has received requests for waiver and interim waiver from several manufacturers from the test procedure in subpart R, appendix C, for basic models of wine cellar refrigeration systems. DOE engaged with AHRI, the industry trade association, to discuss how to develop a consistent alternate testing approach for high-temperature refrigeration systems that would apply to all impacted manufacturers. Ultimately, AHRI submitted a memorandum on behalf of its wine cellar members supporting (1) a 45 °F minimum operating temperature for high-temperature refrigeration systems, and (2) testing at 50 percent of maximum external static pressure, with manufacturers providing maximum external static pressure values to DOE.[50] DOE has granted interim waivers or waivers to the manufacturers listed in Table III.2 for specified basic models of wine cellar refrigeration systems. These waivers provide an alternate test procedure for specific basic models of single-packaged dedicated systems, matched pair, and unit-cooler-only high-temperature refrigeration systems.

In the June 2021 RFI, DOE requested comment on the alternative test procedure for high-temperature refrigeration systems, and if the procedure would be appropriate for basic models other than those specified in the waivers. 86 FR 32332, 32345. AHRI and Lennox both recommended that DOE adopt the test procedures outlined in the waivers. (Lennox, No. 9 at p. 6; AHRI, No. 11 at p. 11) AHRI and Lennox also stated that the ASHRAE 210P subcommittee is evaluating the inclusion of the waiver revisions into their test standard. *Id.*

DOE is proposing to include a test procedure for testing and rating high-temperature matched-pair[51] systems. The proposed test procedure specifies an air entering dry-bulb temperature of 55 °F. DOE proposes that testing high-temperature refrigeration systems that are single-packaged systems be conducted using one of the following: The indoor air enthalpy method; the outdoor air enthalpy method; the compressor calibration method; the indoor room calorimeter method; the outdoor room calorimeter method; or the balanced ambient room calorimeter method as specified in AHRI 1250–2020.

As discussed in the June 2021 RFI, many refrigeration systems for wine cellars are designed for both ducted and non-ducted air delivery. 86 FR 32332, 32345. The current DOE test procedure does not address the testing of ducted systems. In section III.A.1.d, DOE proposed including ducted single-packaged units in the scope of the walk-in test procedure. In section III.A.2.d, DOE proposed a definition for a ducted fan coil unit and proposed removing the restriction of ducts from the definition of a single-packaged unit. The alternate test approach in the waivers requires that testing of ducted units be conducted at 50 percent of the maximum external static pressure (''ESP''), subject to a tolerance of –0.00/+0.05 in. wc.[52] DOE requested feedback on its approach for testing ducted units, if testing at 50 percent of maximum ESP is representative, if there are other industry test methods that include testing of ducted. 86 FR 32332, 32345. Lennox and AHRI supported testing at 50 percent of the maximum ESP, stating

[50] Memorandum from AHRI, ''Department of Energy (DOE) Wine Cellar Cooling Systems Test Procedure Waiver Industry Comments from AHRI Membership,'' August 18, 2020. (EERE–2019–BT–WAV–0028, No. 5 (CellarPro); EERE–2019–BT–WAV–0029, No. 5 (Air Innovations); EERE–2019–BT–WAV–0038, No. 5(Vinotheque); EERE–2019–BT–WAV–022, No. 2 (Vinotemp))

[51] A ''matched refrigeration system'' is also called a ''matched pair'' and is a refrigeration system where the condensing system is distributed into commerce with a specific unit cooler(s). *See* 10 CFR 431.302.

[52] Inches of water column (''in. wc'') is a unit of pressure conventionally used for measurement of pressure differentials.

that it will provide representative performance values. (Lennox, No. 9 at p. 6; AHRI, No. 11 at p. 11) The CA IOUs recommended that DOE require manufacturers to publish the maximum ESP to ensure that consumers do not exceed the maximum static pressure when they install these units so that the efficiency and operating capacity measured by the test procedure are representative of average use. (CA IOUs, No. 14 at p. 4)

Consistent with the waivers that DOE has granted for high-temperature refrigeration systems, DOE proposes to require that testing for ducted systems would be conducted with ducts fitted and at 50 percent of the unit's maximum ESP, subject to a tolerance of –0.00/ +0.05 in. wc. DOE would include this provision to apply to any ducted units, not strictly high-temperature refrigeration systems. DOE proposes adding clarification on how to set ESP as follows. If testing using either the indoor or outdoor air enthalpy method, which includes a measurement of the air volume rate, the airflow measurement apparatus fan would be adjusted to set the external static pressure—otherwise, the external static pressure could be set by symmetrically restricting the outlet of the test duct.

DOE has tentatively determined that requiring manufacturers to publish the maximum ESP could further ensure that the test conditions are representative of installation conditions. DOE intends to address in a future certification rulemaking the certification of the maximum ESP for each ducted unit. However, DOE proposes at this time to include a contingency in the test procedure for those cases where the maximum ESP is not listed in the installation instructions. DOE proposes that if the ESP is not provided, it would be set such that the air volume rate for the test is equal to two-thirds of the value that is measured for zero ESP operation. Making the measurements and adjustments required for this setup step would require use of an airflow measurement apparatus.

Issue 23: DOE requests comment on provisions for setting ESP when testing ducted units.

Finally, in the June 2021 RFI, DOE requested comment on any other issues regarding the testing of wine cellar (high-temperature) refrigeration systems. 86 FR 32332, 32346. Lennox and AHRI suggested that DOE work with wine cellar manufacturers to incorporate high-temperature refrigeration systems adequately as a separate category. (Lennox, No. 9 at p. 7; AHRI, No. 11 at p. 12) Lennox and AHRI also both suggested that there may need to be a high medium temperature category of ducted indoor and outdoor units. *Id.* The same commenters noted the impact of HFC regulations on wine cellar refrigeration and recommended alternative refrigerants be evaluated. *Id.* DOE may evaluate equipment categories and refrigerant requirements for high-temperature refrigeration systems in a future energy conservation standards rulemaking. The CA IOUs recommended that definitions and labeling be developed to clearly differentiate high-temperature refrigeration units from medium temperature units. (CA IOUs, No. 14 at pp. 3–4) In response to the comment from the CA IOUs, DOE has proposed a high-temperature refrigeration system definition that differentiates these units from other refrigeration systems.

7. Variable-, Two-, and Multiple-Capacity Systems

As discussed in the June 2021 RFI, DOE expected the majority of refrigeration equipment within the dedicated condensing class to be certified as dedicated condensing units tested alone, with a much smaller number of systems certified as matched pairs. 86 FR 32332, 32348–32349. DOE's review of CCMS data has confirmed that most certified dedicated condensing unit basic models are dedicated condensing units tested and rated alone rather than matched pairs. This is consistent with comments made during the 2014 and 2016 rulemakings. However, the current DOE test procedure does not include a method for assessing stand-alone multiple- and variable-capacity systems. Similarly, AHRI 1250–2020 does not include test procedures or conditions for indoor variable- or two-capacity units. To address this gap, the ASRAC Working Group recommended that DOE amend its test procedure to allow for separate ratings of stand-alone variable-capacity dedicated condensing units. (ASRAC Term Sheet Recommendation #6)

Historically, refrigeration systems have been designed using a single-speed compressor, which operates at full cooling capacity while the compressor is on. To match the cooling load of the refrigerated space, which in most cases is less than the full cooling capacity of the compressor, a single-speed compressor cycles on and off. In contrast, variable-speed systems employ an inverter-driven compressor that can reduce its speed to match the cooling load. Accordingly, a variable-speed compressor can deliver cooling that more closely matches the load. This can reduce energy use by unloading the system's heat exchangers, allowing them to operate more effectively, and may also allow reduction of fan speeds, which can further enhance savings potential. Emerson's digital technology, used in scroll compressors, can also vary the average refrigerant flow by cycling the engagement of the scroll elements that make up the compressor—the duty cycle of this engagement within a cycle time on the order of 15 to 20 seconds can be varied to adjust average capacity. Similarly, a two- or multiple-capacity compressor can reduce its displacement (volume intake per revolution), for example in a multiple-cylinder reciprocating compressor by ''unloading'' individual cylinders within the compressor. This allows the compressor to more closely match the required cooling load. Other staging technologies have been used, including multiple compressors and scroll compressors with a closable port that deactivates the outermost scroll wraps when open, thus reducing effective displacement. DOE is aware of some multiple- or variable-capacity dedicated condensing units that are currently available on the market using such compressor technologies.[53]

The current DOE test procedure measures the performance of a walk-in condensing unit while operating under a full cooling load at a fixed capacity; *i.e.,* the compressor is operated continuously in its ''on'' state. *See* Tables 11 through 14 of AHRI 1250–2009, and section 3 of subpart R, appendix C, for further details. While AHRI 1250–2009 and AHRI 1250–2020 both include test methods for two-, multiple-, and variable-capacity matched pair refrigeration systems with outdoor dedicated condensing units, there is no test method for such dedicated condensing units when tested alone.

In the June 2021 RFI DOE requested information on the development of test standards for, the efficiency gains of, and the market availability of multiple and variable-capacity systems. 86 FR 32332, 32349. Lennox, AHRI, Keeprite, National Refrigeration, and Hussmann all stated that the market for variable capacity units is low and does not warrant test procedure changes. (Lennox, No. 9 at pp. 9–10; AHRI, No. 11 at p. 14; Keeprite, No. 12 at p. 2; National Refrigeration, No 17 at p. 2; Hussmann, No. 18 at p. 17) Keeprite stated that variable capacity units are most often designed in tandem with the evaporator unit, and that AHRI 1250–

[53] Multiple-capacity product information from one manufacturer can be found at *www.regulations.gov* under Docket EERE–2017–BT–TP–0010, No. 4.

2020 tests were acceptable for all systems on the market. (Keeprite, No. 12 at p. 2) ASAP and NEEA recommended DOE develop a test method for dedicated condensing units tested alone. (ASAP, No. 13 at p. 2; NEEA, No. 16 at p. 2) NEEA notes that no matched systems are certified in CCMS indicating that the lack of test procedure may be limiting market adoption. (NEEA, No. 16 at p. 2) Similarly the CA IOUs stated that accurately measuring the field performance of variable capacity units is key for market adoption. (CA IOUs, No. 14 at p. 2) ASAP noted the ASRAC Working Group's recommendation to develop a test procedure for dedicated condensing units tested alone. (ASAP, No. 13 at pp. 2–3) ASAP, the CA IOUs, and NEEA all recommended that DOE evaluate whether AHRI 1250–2020 has the capability to measure real world cycling conditions of refrigeration systems. (ASAP, No. 13 at p. 2; CA IOUs, No. 14 at pp. 2–3; NEEA, No. 16 at p. 2) The CA IOUs note that this is important for more widespread adoption of variable capacity technology. (CA IOUs, No. 14 at p. 2) The CA IOUs recommended a potential alternative of testing variable capacity systems only as matched systems and having matching guidelines, similar to ASHRAE 29 or AHRI 810. (CA IOUs, No. 14 at p. 3)

DOE acknowledges the small market share of variable- and multiple-capacity units but notes that the ASRAC Working Group agreed to the need for such test procedures for dedicated condensing units tested alone. Because of this, DOE proposes adding test procedures and conditions for variable-, two-, and multiple-capacity dedicated condensing units. DOE also proposes test methods for variable-, two-, and multiple-capacity matched pairs with indoor dedicated condensing units. To support these proposed additions, DOE also proposes to add a definition specifying that a ''multiple-capacity'' refrigeration system is one having three or more stages.

a. Dedicated Condensing Units

As discussed, AHRI 1250–2020 specifies test conditions for matched variable- and multi-capacity refrigeration systems. Because matched pairs are complete refrigeration systems, the test conditions do not address refrigerant conditions in the refrigerant lines connecting the condensing unit and the unit cooler. Instead, the test specifies conditions for the air entering the unit cooler and the air entering the condensing unit. Test procedures for dedicated condensing units tested alone must address refrigerant conditions in the lines that would connect the condensing unit to a unit cooler. For example, Table 12 of AHRI 1250–2020 provides test conditions for fixed capacity refrigerated indoor dedicated condensing units. The table specifies the refrigerant suction dew point return gas temperature at the condensing unit suction inlet—these conditions reflect the operation of a representative unit cooler as well as the temperature rise of refrigerant as it returns to the condensing unit in the suction line. In addition, the test procedure calculations also address the direct energy use of the unit cooler, specifically the unit cooler fan and (for freezer dedicated condensing units) the defrost heater energy input and heat impact. Section 7.9 of AHRI 1250–2020 includes equations providing representative values for some of these parameters—see, *e.g.,* Equation 130 for on-cycle unit cooler power and Equation 118 for off-cycle unit cooler power. Section C10.2.2 in AHRI 1250–2020 includes equations providing representative values for the defrost parameters.

To extend the test procedure to variable- and multiple-capacity dedicated condensing units, the test would need to specify how the parameters representing the unit cooler would change at part-load as compared to full-load. DOE is proposing new test conditions for such models, including values representing the unit cooler and suction line influence on operation at part-load. The proposed test conditions address condensing unit suction inlet refrigerant pressure (represented as dew point temperature) and temperature for the part-load conditions. The condenser air inlet conditions would be the same as for existing tests of dedicated condensing units: Tests only with 90 °F dry bulb entering air temperature for indoor dedicated condensing units, and tests at 95 °F, 59 °F, and 35 °F for outdoor dedicated condensing units. Also, the maximum-capacity test conditions would be the same as the test conditions for a single-capacity condensing unit since maximum-capacity operation of a multiple- or variable-capacity unit should match operation of a single-capacity unit. Specifically, for cooler dedicated condensing units the maximum-capacity suction connection dew point temperature would be 23 °F and the refrigerant temperature would be 41 °F—for freezers, these conditions would be –22 °F and 5 °F. These parameters would need to be defined for the part-load test conditions for variable-, multiple-, and two-capacity dedicated condensing units. In addition, the unit cooler power levels at part-load would have to be specified, if they would be different than for full-load. Defrost parameters would not be expected to be changed for variable-, multiple-, or two-capacity dedicated condensing units as compared with single-capacity condensing units, because the defrost would occur when the dedicated condensing unit compressor is off, and the defrost energy and heat contribution depend primarily on the representative unit cooler.[54]

DOE developed representative values for the part-load refrigerant conditions at the condensing unit suction inlet based on testing of two variable-capacity systems. The testing and the development of the parameters is discussed in greater detail in document EERE–2017–BT–TP–0010–0021, ''Development of Test Rating Conditions for Two-Capacity, Multiple-Capacity, and Variable-Capacity Condensing Units.'' The development is based on the expectation that the unit coolers with which such dedicated condensing units are paired in the field would have two-speed fans, either already installed or retrofitted as part of the condensing unit installation. The test work shows that this inclusion of two-speed fans would be necessary in order to achieve efficiency gains with part-load capacity near or lower than half of the full-load capacity.

(1) Dew Point Target Values for Part-Load Operation: Unit Cooler Exit

As unit cooler-part-load capacity decreases, the suction dew point rises, approaching the temperature of the air entering the unit cooler (''air-entering temperature''). However, when a unit cooler fan switches to reduced speed, the suction dew point falls, in this case from the reduction in unit cooler evaporator effectiveness when operating with less airflow. Note that the unit cooler fan power reduces significantly at reduced speed, and this fan heat reduction can significantly increase net capacity and efficiency at part-load. DOE developed representative trendlines for approach of unit cooler exit evaporating (dew point) temperature to the unit cooler air-entering temperature for both full- and half-speed fan operation.

However, in its development, DOE limited its approach to air-entering temperature to account for the expected exit of superheat. Refrigerant flow

[54] Although the compressor would operate during hot gas defrost, the DOE test procedure calls for testing hot gas defrost dedicated condensing units using the electric defrost default parameters. Section 3.5 of appendix C to subpart R of 10 CFR part 431.

through unit coolers is controlled by expansion devices controlling for the presence of a certain refrigerant superheat level at the unit cooler exit. The test procedure for unit coolers calls for this value to be set at 6.5 °F in case there is no manufacturer-specified level. For such operation, the temperature of the refrigerant leaving the unit cooler is 6.5 °F warmer than the dew point temperature. However, the refrigerant leaving the unit cooler can be no warmer than the entering air. Thus, the approach of dew point temperature to entering air temperature can be no more than 6.5 °F for a unit cooler operating with this level of superheat. Thus, in its development, DOE limited the approach to 7 °F to account for this issue and to provide a 0.5 °F margin.

The selection of dew point temperature at the unit cooler exit for a given part-load operating condition thus depends on the capacity level and the unit cooler fan speed (full or half speed). While different compressor part-load technologies can provide different levels of capacity turndown, DOE developed representative dew point levels based on expectations of likely part-load capacity levels. Specifically, for variable- or multiple-stage dedicated condensing units, the expected minimum level is roughly ⅓ of full capacity, and the expected intermediate level is roughly ⅔ of full capacity. For two-capacity dedicated condensing units, DOE used a representative low-capacity level of roughly half the full-capacity level.

As for unit cooler fan speed, DOE's testing showed that the optimum capacity level for switching between speeds is near ⅔—this means that lower than this capacity level, the higher fan heat and power input associated with full fan operation outweighs the benefit of higher evaporator effectiveness. Hence, in determining the appropriate unit cooler exit condition, DOE assumed that low fan speed would be used if the compressor or compressors run at an operating level less than 65 percent. As mentioned, there are different ways that compressors can achieve part-load conditions. The operating level determination would be based on the compressor technology. Specifically, this would involve the speed ratio for a variable-speed compressor, scroll engagement duty cycle for a digital scroll compressor, or displacement ratio for a staged compressor system that changes displacement at part-load. Hence, for those part-load conditions where the operating level (determined as appropriate for the compressor technology) is less than or equal to 65 percent, the unit cooler exit condition would be based on the low fan trend measured in DOE's test series, and where the operating level is greater than 65 percent, it would be based on the full fan trend. Correspondingly, the fan power used in calculating AWEF would be based on the operating level as well.

(2) Compressor Operating Levels During Testing

In order to clarify the compressor operating level, DOE proposes to define specific terms appropriate for the compressor technologies expected to be used to achieve part-load operation. These terms would be ''duty cycle'' for digital scroll compressors, ''speed ratio'' for variable-speed compressors, and ''displacement ratio'' for compressors or compressor systems that vary the compressor inlet displacement volume to achieve capacity modulation.

DOE proposes the following definitions:

• Displacement Ratio, applicable for a staged positive displacement compressor system, means the swept volume rate, *e.g.,* in cubic centimeters per second, of a given stage, divided by the swept volume rate at full capacity.

• Duty Cycle, applicable for a digital compressor, means the fraction of time that the compressor is engaged and actively compressing refrigerant.

• Speed Ratio, applicable for a variable-speed compressor, means the ratio of operating speed to the maximum speed.

DOE is proposing to specify use of compressor operating levels during part-load testing that are consistent with the development of the representative unit cooler exit dew point targets. For two-capacity compressors, this is straightforward since there is only one part-load operating level. For variable-capacity and multiple-capacity compressors, DOE proposes that the part-load operating levels be the lowest level (*e.g.,* speed, duty cycle, or stage) available for the compressor, and that the intermediate level be the nearest available level to the mean of the full-capacity and minimum-capacity levels. To clarify this proposal, DOE is proposing to define ''Minimum Speed'' and ''Maximum Speed'' as set out in the regulatory text at the end of this document, proposed appendix C1 to subpart R of part 431.

(3) Dew Point Target Values for Part-Load Operation: Condensing Unit Inlet

The previous section discussed the approach for development of appropriate unit representative cooler exit conditions for part-load operation of a condensing unit tested alone. However, performance depends on conditions at the condensing unit inlet. For full-load operation, the test procedure operating conditions are based on assuming that the pressure drop in the suction line is equivalent to a 2 °F reduction in dew point temperature. 81 FR 95758, 95792 (December 28, 2016). For part-load operation, the suction line pressure drop would be lower, due to the reduced refrigerant flow rate. In its development of condensing unit test conditions, DOE assumed that the suction line pressure drop would be equivalent to a dew point reduction of 1 °F when the part-load capacity is 50 percent of the full-load capacity or more and would be 0.5 °F when the capacity is lower (*see* discussion in EERE–2017–BT–TP–0010–0021, ''Development of Test Rating Conditions for Two-Capacity, Multiple-Capacity, and Variable-Capacity Condensing Units''). The suction dew point levels at the condensing unit inlet would then be as indicated in Table III.10 and Table III.11.

TABLE III.10—TWO-CAPACITY DEDICATED CONDENSING UNIT SUCTION DEW POINTS

Application	High-capacity suction dew point, °F	Low capacity, high unit cooler fan speed, suction dew point, °F	Low capacity, low unit cooler fan speed, suction dew point, °F
Cooler	23	25.5	23
Freezer	−22	−19.5	−22

TABLE III.11—VARIABLE-CAPACITY OR MULTIPLE-CAPACITY DEDICATED CONDENSING UNIT SUCTION DEW POINTS

Application	Maximum-capacity suction dew point, °F	Intermediate capacity, high unit cooler fan speed, suction dew point, °F	Intermediate capacity, low unit cooler fan speed, suction dew point, °F	Minimum-capacity suction dew point, °F
Cooler	23	25.5	22	26
Freezer	−22	−19.5	−23	−19

(4) Target Refrigerant Temperature at Condensing Unit Inlet

As discussed previously, the refrigerant temperature at the exit of the representative unit cooler is equal to the unit cooler exit dew point temperature plus the superheat, assumed to be 6.5 °F. The refrigerant warms up in the suction line as it returns to the condensing unit. For full-load operation, the test procedure specifies condensing unit inlet temperature conditions, *i.e.,* 41 °F for cooler dedicated condensing units and 5 °F for freezer condensing units. In a cooler system operating at full-load in a 95 °F outdoor condition, this means that the refrigerant is warmed from 31.5 °F at the unit cooler exit to 41 °F at the condensing unit inlet. Most of this warmup would be expected to occur where the suction line is exposed to 95 °F outdoor conditions, since the cooler interior temperature at 35 °F is only a few degrees warmer than the refrigerant exiting the unit cooler. The suction line exposed to outdoor air conditions can be seen as a heat exchanger with low effectiveness. For the purposes of determining the trend of suction line refrigerant temperature increase at part-load, DOE assumed that the suction line thermal resistance would remain the same as the capacity level changes. This means that when refrigerant flow is lower at part-load, the heat transfer effectiveness would be higher, and the refrigerant temperature rise would be greater. (See the more detailed discussion in EERE–2017–BT–TP–0010–0021, ''Development of Test Rating Conditions for Two-Capacity, Multiple-Capacity, and Variable-Capacity Condensing Units'') The document discusses in more detail how the suction line temperature rise was calculated for different operating conditions and related to the operating capacity level of the condensing unit. Note that for refrigerated outdoor dedicated condensing units using test condition C, no change in the condensing unit inlet temperature is assumed for different capacity levels, because the 41 °F specified for single-capacity systems already suggests a suction line heat transfer effectiveness greater than 100 percent. Hence, DOE proposes no change in condensing unit inlet temperature for cooler dedicated condensing units for condition C.

TABLE III.12—TWO-CAPACITY DEDICATED CONDENSING UNIT RETURN GAS CONDITIONS

Test title	Unit cooler fan level corresponding to compressor operating level	Freezer return gas, °F	Cooler return gas, °F
Capacity, Condition A, Low Capacity	Low	13.5	45.0
	High	12.0	42.5
Capacity, Condition A, High Capacity	High	5	41
Capacity, Condition B, Low Capacity	Low	13.0	41.0
	High	11.5	41.5
Capacity, Condition B, High Capacity	High	5	41
Capacity, Condition C, Low Capacity	Low	12.0	42.5
	High	10.5	41.0
Capacity, Condition C, High Capacity	High	5	41

TABLE III.13—VARIABLE-CAPACITY DEDICATED CONDENSING UNIT RETURN GAS CONDITIONS

Test title	Unit cooler fan level corresponding to compressor operating level	Freezer return gas, °F	Cooler return gas, °F
Capacity, Condition A, Minimum Capacity	Low	26.5	53.0
Capacity, Condition A, Intermediate Capacity	Low	10.5	43.0
	High	12.0	45.5
Capacity, Condition A, Maximum Capacity	High	5	41
Capacity, Condition B, Minimum Capacity	Low	24.0	46.0
Capacity, Condition B, Intermediate Capacity	Low	10.0	40.0
	High	11.5	41.5
Capacity, Condition B, Maximum Capacity	High	5	41
Capacity, Condition C, Minimum Capacity	Low	20.0	41.0
Capacity, Condition C, Intermediate Capacity	Low	10.0	41.0
	High	10.5	41.0
Capacity, Condition C, Maximum Capacity	High	5	41

(5) Unit Cooler Power To Use for AWEF Calculations

As discussed previously, the proposed test for dedicated condensing units with more than one compressor capacity is based on the expectation that a representative unit cooler with which the condensing unit would be paired in the field will have or be fitted with during installation a two-speed or variable-speed fan, and that the fan would operate at half-speed as appropriate for part-load operation. Also discussed previously, the unit cooler dew point target for the test depends on the assumption for unit cooler fan operating condition, and DOE is proposing that half-speed would be used for compressor operating levels up to 65 percent. AHRI 1250–2020 already provides power input levels for a representative unit cooler with fans operating at full- and half-speed levels (for example, see Equations 118 and 130 of the test standard, providing representative wattages for off-cycle and on-cycle wattages). DOE proposes that the half-speed off-cycle wattage would also be used for half-speed on-cycle operation when calculating AWEF.

(6) Other Aspects of AWEF Calculations

DOE proposes that the calculations used to determine AWEF for dedicated condensing units with more than one capacity level would be essentially identical to the calculations for matched pair or single-packaged dedicated systems once capacity and power input are determined for each standard operating condition at the different capacity levels. However, this proposal would adjust the calculation methods for variable- and multiple-capacity systems, consistent with the direction taken for calculating efficiency metrics for variable-capacity central air conditioners and heat pumps in the test procedure final rule published in 2016 for those products. These changes are described in section III.G.7.c of this document.

Issue 24: DOE requests comments on its proposals for testing multiple-, variable-, and two-capacity dedicated condensing units tested alone. DOE specifically requests comments on (a) the expectation that a unit cooler with which such a condensing unit is paired in the field would have two-speed (or variable-speed) fans or be fitted with such fans during installation, (b) the proposed compressor operating levels to use for testing, (c) the proposed compressor operating level at which the unit cooler fan would be assumed to switch to half-speed, (d) the proposed targets for unit cooler exit and condensing unit inlet refrigerant temperatures and dew point target temperatures, and (e) the unit cooler half-fan-speed input wattage.

(7) Information Required for Testing

Testing of dedicated condensing units with multiple capacity levels requires setting operating conditions for testing that are not required when testing single-capacity dedicated condensing units. DOE expects that some of this information may not be readily available in installation instructions and may consider whether certification of some of the required information may be needed in a separate rulemaking addressing certification.

(8) Potential Use of Equations Rather Than Tabulated Values for Target Test Conditions

The proposed tabulated target values for suction dew point and suction temperature for part-load operation of dedicated condensing units shown in Table III.10 through Table III.13 were using correlations for the trends of unit cooler operation and suction line pressure drop and heat transfer developed based on test data (*See* the discussion in EERE–2017–BT–TP–0010–0021, ‘‘Development of Test Rating Conditions for Two-Capacity, Multiple-Capacity, and Variable-Capacity Condensing Units’’) The target values also consider likely compressor minimum operating levels and decisions regarding the unit cooler fan operating level corresponding to each compressor operating level. Rather than use a tabular approach to specifying target operating conditions, DOE could consider direct use of the correlations for determination of target test conditions. The approach would involve, for each part-load test, using (1) two correlations to calculate the target condensing unit suction inlet dew point, and (2) two equations to calculate target condensing unit suction inlet temperature. This approach would provide more flexibility in manufacturer decisions regarding the unit cooler fan level corresponding to any given compressor staging level and slightly better alignment of the test conditions to the compressor operating levels. However, it would require manufacturers to provide more information regarding selection of test conditions to clarify how models were tested and could be considered more burdensome by requiring calculation of test conditions. Depending on comments provided on this topic, DOE may consider adopting this approach of using the correlations for unit cooler and suction line trends instead of the tabulated values for setting target test conditions.

Issue 25: DOE requests comment on whether DOE should set the target test conditions using correlations for unit cooler and suction line response to part-load operation rather than the proposed tabular approach.

b. Indoor Matched Pair and Single-Packaged Units

As discussed previously, AHRI 1250–2020 does not include test procedures or conditions for indoor variable or multiple-capacity units. As with dedicated condensing units, DOE proposes to adopt test methods for indoor matched pair and single-packaged dedicated systems. Testing of these systems and calculating AWEF for them would require parallel testing and AWEF calculations for outdoor matched systems, except that there is only one test condition and the AWEF calculation would be based only on that one condition. The details for required test conditions and calculations are presented in section 4.5.6 and Table 17 and Table 18 of this document showing the proposed regulatory text revisions.

Issue 26: DOE requests comment on its proposal to include in its test procedures instructions for testing and determining representations for indoor matched pair and single-packaged dedicated systems.

c. Revision to EER Calculation for Outdoor Variable-Capacity and Multiple-Capacity Refrigeration Systems

AHRI 1250–2020 includes test conditions and calculations to determine representations, specifically AWEF, for refrigeration systems having variable-capacity capability. The calculations use a quadratic equation for determining system EER for intermediate-capacity operation (*see, e.g.,* Equations 76 through 84 of AHRI 1250–2020). DOE moved from the same quadratic approach for central air conditioners and heat pumps (‘‘CAC/HP’’) to a linear interpolation method due to concerns about potential inaccuracies of this method. 82 FR 1426, 1440–1441 (January 5, 2017). DOE proposes to make the same change when testing WICF refrigeration systems.

Issue 27: DOE requests comment on its proposal to modify the approach for calculating intermediate-capacity EER for variable-speed refrigeration systems.

d. Digital Compressors

Dedicated condensing units with digital compressors have been commercialized (*see, e.g.,* EERE–2017–BT–TP–0010–0020). Digital compressor operation is discussed in the introduction to section III.G.7 of this document. To clarify the proposed test procedure for digital compressors, DOE proposes to define the term ''digital compressor'' as a compressor that uses mechanical means for disengaging active compression on a cyclic basis to provide a reduced average refrigerant flow rate in response to an input signal.

DOE testing has shown that operating tolerances specified in AHRI 1250–2020 for certain parameters such as refrigerant pressure and mass flow can be exceeded when a digital compressor operates at part-load. Nevertheless, DOE testing has shown that the refrigerant enthalpy method for measuring capacity may still be quite accurate, as long as the liquid subcooling at the mass flow meter is sufficiently low, as required in Section C3.4.5 of AHRI 1250–2020. When conducting these tests, DOE used an integrating mass flow meter and measurement of temperature and pressure at a frequency of one measurement per second. DOE calculated capacity using refrigerant enthalpies determined based on test-period-average values of refrigerant temperature and pressure. When meeting the mass flow meter subcooling requirements, capacity balance with a separate calorimetric capacity measurement ranged from 0.2 to 4.1 percent.

Thus, DOE proposes that testing of refrigeration equipment with digital compressors operating at part-load may use the refrigerant enthalpy method as a secondary test method, with the following provisions and adjustments: (1) Pressure and temperature measurement would be at a frequency of once per second or faster, (2) the operating tolerances for pressure and temperature at both the inlet and outlet connections, and for mass flow would not apply, and (3) enthalpies determined for the capacity calculation would be based on test-period-average pressure and temperature values.

DOE proposes that the selection of the primary test method for measuring capacity would depend on the refrigeration system configuration. For single-packaged dedicated systems, the test methods proposed to be used as primary methods for any single-packaged dedicated system would be used (see discussion in section III.G.2of this document). For matched pairs, the same test methods allowed as primary methods for single-packaged dedicated systems would be used. For dedicated condensing units, the primary methods that would be used would include outdoor air enthalpy method, balanced ambient outdoor calorimeter, and outdoor room calorimeter measurements.

Issue 28: DOE requests comments on its proposals to address part-load testing for refrigeration systems with digital compressors.

8. Defrost

The April 2011 final rule referenced AHRI 1250–2009 as DOE's WICF refrigeration system test procedure, including that standard's requirement that both frosted and dry coil defrost tests be conducted. 81 FR 21580, 21597. DOE later noted in a supplemental notice of proposed rulemaking published on February 20, 2014 (''February 2014 SNOPR'') that these tests may be overly burdensome for manufacturers to conduct due to the difficulty of maintaining the moist air infiltration conditions for the frosted coil test in a repeatable manner. 79 FR 9818, 9831. Accordingly, in the May 2014 final rule, DOE adopted a set of nominal values for calculating defrost energy use for a frosted coil, number of defrosts per day if the unit has an adaptive defrost system, and daily contribution of heat load. 79 FR 27388, 27401. To address testing low-temperature dedicated condensing units alone, the May 2014 final rule established nominal values for the defrost energy use and thermal load. In addressing refrigeration systems with hot gas defrost, the May 2014 final rule established nominal values for calculating hot gas defrost energy use and heat load.[55] *Id.*

The December 2016 final rule removed the method for calculating the defrost energy and defrost heat load of systems with hot gas defrost and established a new method to evaluate hot gas defrost refrigeration systems. That new method treated hot gas defrost refrigeration systems as if they used electric defrost rather than hot gas defrost. This method relied on the same nominal values for defrost energy use and thermal load that the test procedure prescribes for electric-defrost dedicated condensing units that are tested alone. 81 FR 95758, 95774–95777. This approach was modified in the March 2021 final rule, which amended the DOE test procedure by rating hot gas defrost unit coolers using modified default values for energy use and heat load contributions that would make their ratings more consistent with those of electric defrost unit coolers. 86 FR 16027. The scope of the March 2021 final rule is limited to unit coolers only. 86 FR 16027, 16030.

In the June 2021 test procedure (''TP'') RFI, DOE stated that it was considering whether to include a test method for determining the energy use associated with defrost and/or a test method to assess and confirm defrost adequacy. 86 FR 32332, 32347. DOE observed that any test method for determining defrost energy use and adequacy would have to provide consistent, repeatable methods for (1) delivering a frost load to the test coil and (2) measuring the thermal load released into the refrigerated space during the defrost cycle, regardless of the method of defrost (*e.g.,* electric or hot gas defrost), all while ensuring that the procedure provides results reflecting energy usage during a representative average use cycle and not be unduly burdensome to conduct. *Id.* DOE requested information on methods that might provide a measurable frost load and frost type to ensure repeatable defrost testing. Additionally, DOE requested data on typical frost loads and frost type, or information on the type and amount of testing that would be necessary to validate a method for evaluating frost loads and frost types during defrost testing. *Id.*

In response to DOE's request for comment, Lennox, AHRI, National Refrigeration, and Hussmann recognized that although the injector system included in appendix E of AHRI 1250–2020 is an improvement, it remains a challenge to consistently build frost on an evaporator coil while minimizing interference with calorimeter systems. (Lennox No. 9 at p. 8; AHRI No. 11 at p. 13; National Refrigeration No. 17 at p. 2; Hussmann No. 18 at p. 15 Keeprite reiterated the technical difficulties associated with a moist-air loading approach. (Keeprite No. 12 at p. 2) Each of these stakeholders urged DOE to wait for the completion of ASHRAE research project WS 1831, ''Validation of a Test Method for Applying a Standardized Frost Load on a Test Evaporator in a Test Chamber with an Operating Conditioning System'' (''WS 1831''), before modifying its defrost test procedure. (Lennox No. 9 at p. 8; AHRI No. 11 at p. 13; National Refrigeration No. 17 at p. 2; Hussmann No. 18 at p. 15) ASAP also recognized the challenge associated with developing a test method to measure defrost energy (ASAP No. 13 at p. 2), while the CA IOUs agreed that AHRI 1250–2020 appendix E provides a good starting point for a universal defrost test but urged DOE to work with stakeholders to develop a test procedure for defrost that

[55] In a ''hot gas'' defrost system, high-temperature, high-pressure hot refrigerant gas from the discharge side of the compressor is introduced into the evaporator, where it condenses, thereby releasing latent heat into the evaporator. This heat is used to melt the frost that has accumulated on the outside of the evaporator coil.

could be used for all walk-in equipment. (CA IOUs No. 14 at p. 3) More specifically, the CA IOUs suggested that a test procedure for determining defrost energy consumption would vary the length and intensity of moisture injections to better represent field conditions. *Id.* Similarly, ASAP stressed that the ASRAC Working Group recommended incorporating a test method for measurement of defrost energy consumption and encouraged DOE to develop a future test method that better captures defrost energy use and performance for all defrost systems. (ASAP No. 13 at p. 2)

DOE recognizes that it is challenging to consistently build frost on an evaporator coil to assess a unit's defrost performance. In Section C11 of AHRI 1250–2009, the moisture to provide a frost load is introduced through the infiltration of air at a 75.2 °F dry-bulb temperature and a 64.4 °F wet-bulb temperature into the walk-in freezer at a constant airflow rate that depends on the refrigeration capacity of the tested freezer unit (equations C11 and C12 in Section C11.1.1 of AHRI 1250–2009). A key issue with this approach is the difficulty in ensuring repeatable frost development on the unit under test, despite specifying the infiltration air dry-bulb and wet-bulb temperatures. For example, in addition to frost accumulating on the evaporator of the unit under test, frost may also accumulate on the evaporator of other cooling equipment used to condition the room, which could subsequently affect the rate of frost accumulation on the unit under test (by affecting the amount of moisture remaining in the air).

In past ASHRAE-supported research, researchers created a frost load by introducing steam directly into the refrigerated space.[56] However, as discussed in 1094–RP, this approach can result in the suspension of ice crystals in the saturated room air and the formation of snow-like frost on the test coils. The researchers found that this snow-like frost degrades refrigeration system performance more, and is more difficult to defrost, than the ice-like frost that forms in sub-saturated air conditions. Both 622–RP and 1094–RP observed that a significant portion of the coil frost was converted to water vapor rather than melted during the defrost cycle. This finding suggests that measuring the quantity of frost melt water mass may be a poor indicator of the frost load, since a significant portion of the frost would not be captured as melt water.[61]

DOE is aware that ASHRAE initiated project WS 1831 on September 2, 2021. The purpose of this research is to examine different approaches for applying a standardized, repeatable, full-frost accumulation (*i.e.,* accumulation of a frost quantity that would typically accumulate between defrosts during system operation in moist conditions) on evaporator coils so that the subsequent defrost test provides a representative indication of energy use associated with defrosting a frosted coil. Indirect methods for determining full frost load might include air side temperature, humidity, or pressure drop, refrigerant-side evaporation temperature or pressure, compressor or unit cooler fan power consumption, or the refrigerant-to-air or air-side inlet-to-outlet temperature difference.

Since the defrost test procedure in AHRI 1250–2009, section C11 has limitations, AHRI 1250–2020 does not include a frosted-coil test but does include provisions for a dry-coil defrost test.[57] Industry is currently evaluating how to create and validate consistent evaporator coil frost loads; therefore, DOE proposes to maintain the current calculation-based approach for estimating defrost energy consumption. Specifically, DOE proposes to incorporate by reference Section C10 of AHRI 1250–2020 for unit coolers with either electric or hot gas defrost.

In the June 2021 RFI, DOE requested comment on whether these and other updates to AHRI 1250–2020 would, if incorporated by DOE, result in additional testing burden. 86 FR 32332, 32336. Lennox, AHRI, Keeprite, and Hussmann recommended that DOE omit Section C10.2.1.1 of AHRI 1250–2020 from its test procedure since it does little to make the test procedure more representative but introduces technical challenges associated with air conditions during the dry coil defrost test. (Lennox No. 9 at p. 3; AHRI No. 11 at p. 5; Keeprite No. 12 at p. 1–3; Hussmann No. 18 at p. 6–7) Section C10.2.1.1 of AHRI 1250–2020 specifies that the general test condition tolerances are not applicable but does require that the indoor entering dry-blub temperature must be less than or equal to 4 °F and that air velocity in the vicinity of the test unit must not exceed 500 feet per minute. At this time, DOE does not have sufficient data to fully evaluate how these test room condition requirements during the dry coil defrost test would impact the representativeness of the test procedure relative to any potential additional test burden. DOE has tentatively decided not to incorporate Section C10.2.1.1 of AHRI 1250-but will instead continue to investigate this issue and may decide to include dry coil defrost operating tolerances in a later rulemaking. While DOE will continue to evaluate the dry coil defrost test room conditions, DOE emphasizes that it is proposing to incorporate the entirety of Section C10 of AHRI 1250–2020, ''Defrost Calculation and Test Methods,'' by reference, except for Section C10.2.1.1, ''Test Room Conditioning Equipment.''

In the following sections, DOE discusses relevant stakeholder comments and additional proposals for adaptive defrost and hot gas defrost.

a. Adaptive Defrost

Adaptive defrost refers to a factory-installed defrost control system that reduces defrost frequency by initiating defrosts or adjusting the number of defrosts per day in response to operating conditions rather than initiating defrost strictly based on compressor run time or clock time. 10 CFR 431.303. In the December 2016 final rule, DOE established an approach to address systems with adaptive defrost. 81 FR 95758, 95777. This approach requires that adaptive defrost features are deactivated during certification testing; *i.e.,* for certification, units are tested as if they do not have adaptive defrost. *See* subpart R, appendix C, section 3.3.5. However, DOE's current approach also allows the energy saving benefits of adaptive defrost to be displayed in public representations and marketing material (but not for certification purposes). *Id.* To represent the benefits of adaptive defrost, a calculation method is provided that allows the unit under test to reduce its number of defrosts per day (''N_{DF}'') to the average of its daily dry coil and frosted coil defrosts (typically 1 and 4, respectively, for an average of 2.5), rather than basing N_{DF} on the number of frosted coil defrosts per day (typically 4). *Id.* DOE's current approach applies to all refrigeration system configurations (*i.e.,* matched pairs, unit coolers tested alone, and dedicated condensing units tested alone).

[56] Sherif, S.A., P.J. Mago, and R.S. Theen. *A Study to Determine Heat Loads Due to Coil Defrosting.* 1997. University of Florida: Gainesville, FL. ASHRAE Project No. 622–RP. Report No. UFME/SEECLSEE–9701 (''622–RP'') and Sherif, S.A., P.J. Mago, and R.S. Theen. *A Study to Determine Heat Loads Due to Coil Defrosting-Phase II.* 2003. University of Florida: Gainesville, FL. ASHRAE Project No. 1094–RP. Report No. UFME/SEECLSEE–200201 (''1094–RP'').

[57] AHRI 1250–2020 includes an adaptive defrost challenge test in appendix E (''Appendix E'') and a hot gas defrost challenge test in appendix F (''Appendix F'') that require a frosted coil. The tests in both of these appendices are labelled as ''informative,'' and were designed to evaluate adaptive defrost or hot gas defrost functionality, respectively, rather than to quantify defrost energy use.

In the June 2021 TP RFI, DOE observed that a test method to evaluate the impact of adaptive defrost must evaluate (1) whether a system waits too long to defrost (*i.e.,* too much frost builds up on the coils, which impacts on-cycle performance) and (2) if the system defrosts more than four times per day, which is typical for a conventional timed defrost. 86 FR 32332, 32348. DOE requested comment on how the performance of adaptive defrost systems should be accounted for in the walk-in test procedure and which refrigeration systems (*i.e.,* matched pairs, unit coolers tested alone, and dedicated condensing units tested alone) should be eligible for a potential adaptive defrost test procedure. Lennox, AHRI, Keeprite, National Refrigeration, and Hussmann stated that adaptive defrost is most prevalent in matched pairs and that it would be necessary to match unit coolers and dedicated condensing units to realize adaptive defrost. (Lennox, No. 9 at p. 9; AHRI, No. 11 at p. 14; Keeprite, No. 12 at p. 2; National Refrigeration, No. 17 at p. 2; Hussmann, No. 18 at p. 16) The CA IOUs encouraged DOE to develop a test to measure the performance benefits of adaptive defrost. (CA IOUs, No. 14 at p. 3) While the CA IOUs stated that Appendix E of AHRI 1250–2020 provides a good starting point for a defrost test, they suggested that the addition of moisture as a static load of 0.5 pounds per hour per 1,000 Btu per hour in Appendix E does not evaluate the full capability of most adaptive defrost systems and does not sufficiently differentiate between adaptive control strategies. (CA IOUs, No. 14 at p. 3)

DOE also requested data showing the performance of adaptive defrost systems relative to non-controlled defrost systems, data showing the impact of adaptive defrost to on-cycle operation, and data demonstrating seasonal or daily frosting patterns for walk-in applications. 86 FR 32332, 32348. In response, the CA IOUs shared test results from adaptive defrost control systems installed in the field which show between 0 and 30 percent energy savings compared to baseline systems with no adaptive defrost control. (CA IOUs, No. 14 at p. 3) Accordingly, the CA IOUs encouraged DOE to consider varying the length and intensity of moisture injections to better represent in-field frost load and differentiate between control strategies. *Id.*

DOE recognizes the need to develop a representative and repeatable test method for evaluating adaptive defrost performance, and notes that appendix E may be an appropriate starting point. DOE also acknowledges that industry is invested in developing an adaptive defrost test procedure and that the ASHRAE WS 1831 research project must be completed in order to understand how to best form a representative and uniform layer of frost on the defrost coil. DOE appreciates the information provided by the CA IOUs and will consider it in its development and/or evaluation of any newly developed test procedure for quantifying the energy use of adaptive defrost. After considering the stakeholder comments received, DOE proposes to maintain the current regulatory approach that reduces the number of defrosts per day in the AWEF calculation from 4.0 to 2.5, for adaptive defrost systems. DOE also proposes to maintain its approach where AWEF calculated using the adaptive defrost credit (*i.e.,* using 2.5 defrosts per day, rather than 4.0) may be used for representation purposes only, and may not be used when calculating AWEF for compliance with DOE energy conservation standards. DOE also proposes to maintain its current approach, in which the adaptive defrost calculation method is applicable to all refrigeration system configurations (*i.e.,* matched pairs, unit coolers tested alone, and dedicated condensing units tested alone). Finally, DOE notes that use of the adaptive defrost credit for representation purposes only would continue to apply only to factory-installed defrost control systems. Overall, the optional adaptive defrost strategy that DOE is proposing for representation purposes can be summarized as follows:

- The adaptive defrost calculation method (*i.e.,* the adaptive defrost "credit") may be used only for representation purposes, and may not be used to calculate AWEF for compliance purposes.
- All refrigeration system configurations (*i.e.,* matched pairs, unit coolers tested alone, and dedicated condensing units tested alone) may use the adaptive defrost calculation method for representation purposes.
- Refrigeration systems may use the adaptive defrost calculation method for representation purposes only if the adaptive defrost controller is distributed in commerce with the refrigeration system.

b. Hot Gas Defrost

As discussed previously, the March 2021 final rule amended the test procedure to rate hot gas defrost unit coolers using modified default values for energy use and heat load contributions that would make their ratings more consistent with those of electric defrost unit coolers but is limited to unit coolers only. 86 FR 16027, 16030.

In the June 2021 TP RFI, DOE discussed that it was interested in obtaining feedback on the most practicable method for measuring hot gas defrost performance. 86 FR 32332, 32347. DOE recognized that in order to assess the energy performance of a defrost cycle, the test procedure must measure both the energy consumed and the heat released into the refrigerated space by the defrost system. *Id.* DOE further discussed that for hot gas defrost systems, unlike electric resistance heating systems, the energy consumed and the heat released are not equivalent, which makes the current electric defrost test procedure outlined in AHRI 1250–2009 inappropriate for hot gas defrost systems. *Id.*

DOE stated that it is not aware of a test method that can reliably be used to directly measure the thermal impact of hot gas defrost without a substantial increase in test burden and mentioned that it was therefore considering the use of a calculation method. *Id.* Rather than measure the energy used and heat released into the refrigerated space for the unit-under-test, the energy use and heat load could be calculated as a function of the refrigeration system's steady state capacity. *Id.* DOE further discussed that the energy use and heat load to capacity relationships could be defined based on test data from actual hot gas defrost systems. *Id.* DOE recognized that AHRI has developed a calculation method to represent hot gas defrost heat load and energy use contributions. *Id.* This method is provided in Section C10.1 of AHRI 1250–2020 and prescribes equations to represent energy use and heat addition associated with defrost for different system configurations (matched pair, single-packaged dedicated, unit cooler, condensing unit) and considers whether hot gas is used only to defrost the evaporator or whether it also maintains warm temperatures in the drip pan.

Finally, DOE discussed that if it were to amend its walk-in refrigeration systems test procedure to account for hot gas defrost energy consumption and heat load, DOE would need to decide if all refrigeration system configurations (*i.e.,* matched pairs, unit coolers tested alone, and dedicated condensing units tested alone) would be subject to a hot gas defrost-specific test procedure. *Id.*

In their comments, AHRI, Lennox, Keeprite, Hussmann, and National Refrigeration each recommended that DOE utilize the AHRI 1250–2020 hot gas defrost calculations for all equipment types, since matched pairs, unit coolers, and dedicated condensing units may be associated with hot gas defrost. (AHRI, No. 11 at pp. 13–14; Lennox, No. 9 at pp. 8–9; Keeprite, No. 12 at p. 2; Hussmann, No. 18 at pp. 15–16; National Refrigeration, No. 17 at p. 2) ASAP also supported the adoption of the hot gas defrost calculations in AHRI 1250–2020 but did not specify for which equipment systems. (ASAP, No. 13 at p. 2) NEEA observed that AHRI 1250–2020 provides both a calculation approach and a test method to account for hot gas defrost energy and recommended that DOE proceed with the hot gas defrost calculations in AHRI 1250–2020 in addition to including the hot gas defrost challenge test in Appendix F of AHRI 1250–2020. (NEEA, No. 16 at p. 3) In spite of its inability to capture frost load conditions, the CA IOUs nevertheless supported the use of AHRI 1250–2020 Appendix F since it captures hot gas defrost energy use. (CA IOUs, No. 14 at p. 2) Both NEEA and the CA IOUs observed that additional work is needed to develop a robust test method to evaluate how hot gas defrost impacts equipment energy consumption and NEEA recommended that DOE continue to work with industry groups to develop such a procedure. (NEEA, No. 16 at p. 3; CA IOUs, No. 14 at p. 2)

After reviewing the comments submitted by AHRI, Lennox, Keeprite, Hussmann and National Refrigeration, DOE has tentatively determined that all refrigeration system configurations (*i.e.,* matched pairs, unit coolers tested alone, and dedicated condensing units tested alone) can benefit from hot gas defrost. For this reason, DOE proposes that all system configurations (when equipped with hot gas defrost) should be eligible for a hot gas defrost ''credit,'' which will be discussed in more detail in the following paragraphs.

As discussed previously, there is currently no industry-accepted test method that can measure the heat load addition coming from hot gas defrost operation. In the absence of such a method, DOE is not able to propose a hot gas defrost testing-based method at this time. However, if the walk-in industry develops such a method in the future, DOE may evaluate that method's appropriateness in a future rulemaking.

While all stakeholders support a calculation-based approach using the hot gas defrost equations in AHRI 1250–2020, DOE's goal in the December 2016 final rule was to provide calculations for rating hot gas defrost unit coolers using modified default values for energy use and heat load contributions that would make their ratings more consistent with those of electric defrost unit coolers. 81 FR 95758, 95776. The March 2021 final rule sought to maintain this consistency between units configured with hot gas defrost or electric defrost and ultimately included the equations in Section C10.2 of AHRI 1250–2020 for representing the defrost energy use and thermal load associated with hot gas defrost systems. 86 FR 16027, 16032. DOE proposes to maintain this calculation equivalence between hot gas defrost and electric defrost systems. Specifically, for rating and certification, all walk-in refrigeration systems would utilize the default values for energy use and heat load for dedicated condensing units tested alone with electric defrost systems. AHRI 1250–2020, Section 10.2.2.

However, like the approach discussed previously for adaptive defrost systems, DOE is proposing that manufacturers may account for a unit's potential improved performance with hot gas defrost in its market representations. In other words, DOE proposes that manufacturers may apply a hot gas defrost ''credit'' in their market representations but must certify hot gas defrost units using the default electric defrost equations. As mentioned previously, AHRI has developed specific equations for determining the defrost energy and heat load associated with hot gas defrost. AHRI 1250–2020, Section C10.1. DOE proposes that the hot gas defrost ''credit'' may be used in marketing materials for all refrigeration system configurations sold with hot gas defrost (*i.e.,* matched pairs, unit coolers tested alone, and dedicated condensing units tested alone).

9. Refrigerant Glide

In the June 2021 RFI, DOE discussed that it was considering changing its test procedure to a more refrigerant-neutral approach—specifically, DOE discussed that it was considering approaches that would more accurately represent the performance of zero-, low-, and high-glide refrigerants. 86 FR 32332, 32351. Refrigerant glide refers to the increase in temperature at a fixed pressure as liquid refrigerant vaporizes during its conversion from saturated liquid (at its bubble point) to saturated vapor (at its dew point). R–404A—a common walk-in refrigerant—has very little glide, while R–407A—another common walk-in refrigerant—can exhibit glide of up to 8 °F.[58]

The current DOE test procedure specifies unit cooler test conditions based on the dew point at the evaporator exit. For zero-glide refrigerants, the average evaporator temperature will typically be equivalent to the specified dew point. However, for high-glide refrigerants, the average evaporator temperature will be significantly lower than the dew point since the refrigerant temperature will increase (up to the dew point) as it travels through the evaporator. As a result, two identical unit coolers, one charged with R–404A and one with R–407A, will be tested at different evaporator-to-air temperature differences (''TD''), but with the same evaporator airflow. Measured capacity is directly correlated with the product of TD and airflow; therefore, the high-glide R–407A unit cooler would achieve a higher rated capacity than the R–404A unit cooler. However, this capacity difference is an artifact of the test procedure, which requires that unit coolers and dedicated condensing units be tested alone. In the field, a unit cooler will be paired with a dedicated condensing unit and R–407A unit coolers will not actually provide additional capacity when compared to their R–404A counterparts.

For these reasons, the current test procedure is not refrigerant-neutral. In the June 2021 RFI, DOE discussed the possibility of pursuing a modified midpoint approach, which DOE believed may be more refrigerant-neutral. 86 FR 32332, 32355. The modified midpoint approach attempts to standardize the average evaporator

[58] As noted in the June 2021 RFI, on July 20, 2015, the U.S. Environmental Protection Agency (''EPA'') published a final rule under the Significant New Alternatives Policy (''SNAP'') program listing the use of certain hydrofluorocarbons (''HFCs'') as unacceptable, including the use of R–404A in WICF refrigeration systems. 80 FR 42870 (''July 2015 EPA SNAP Rule''). On December 1, 2016, EPA published a final rule (''December 2016 EPA SNAP Rule'') which listed a number of refrigerants, included R–407A, for use in certain refrigerant applications as unacceptable starting January 1, 2023 for cold storage warehouse application, and January 1, 2021, for retail food refrigerant applications. 81 FR 86778. In August 2017, the U.S. Court of Appeals for the District of Columbia Circuit vacated and remanded the July 2015 EPA SNAP Rule to the extent that it required manufacturers to replace HFCs with a substitute substance. (*Mexichem Fluor, Inc.* v. *EPA,* Case No. 15–1328 (D.C. Cir. August 8, 2017)) A petition for rehearing has been filed by a number of parties. (D.C. Cir., Consolidated Case Nos. 15–1328, 15–1329). That petition for rehearing was denied on January 26, 2018.

Additionally, in October 2016, the 28th Meeting of the Parties to the Montreal Protocol adopted the Kigali Amendment on HFCs. The Kigali Amendment enters into force on January 1, 2019, and it requires parties to the protocol to reduce consumption and production of HFCs. DOE understands that, while the United States has not yet ratified the Kigali Amendment, a significant portion of WICFs currently use HFC-based refrigerants and may become affected by this Amendment to the Montreal Protocol.

DOE plans to consider the potential impact of the court's decision and the Amendment to the Montreal Protocol in this rulemaking as appropriate.

temperature, rather than standardizing the evaporator dew point. In doing so, identical unit coolers using zero- and high-glide refrigerants would exhibit identical TDs, thus alleviating concerns of overstated capacity. DOE requested comment on the appropriateness of a modified midpoint approach and how such a method could be implemented in the June 2021 RFI. 86 FR 32332, 32355. Lennox, AHRI, Keeprite, National Refrigeration, and Hussmann recommended maintaining the current dew point approach since dewpoint is measurable and the approach is accepted in the industry. (Lennox, No. 9 at p. 11; AHRI, No. 11 at p. 16; Keeprite, No. 12 at p. 3; National Refrigeration, No. 17 at p. 2; Hussmann, No. 18 at p. 20) Lennox, AHRI, and Hussmann also stated that dew point is a required reference for dual instrumentation evaporator superheat calculations and can be measured during installation and service. (Lennox, No. 9 at p. 11; AHRI, No. 11 at p. 16; Hussmann, No. 18 at p. 20) Keeprite claimed that a midpoint or corrected midpoint approach is unproven and is not measurable. (Keeprite, No. 12 at p. 3) Keeprite additionally added that a change from dewpoint to midpoint may have large effects on unit cooler AWEF values. *Id.* Daikin stated that engineers use the mean value between dew point and bubble point when designing refrigeration systems since this approach simplifies energy calculations. (Daikin, No. 17 at p. 4)

DOE acknowledges the potential increased testing burden highlighted by manufacturers if a modified midpoint were to be adopted. In response to these comments DOE proposes to continue to use dewpoint throughout the test procedure but will continue to evaluate the potential for using a midpoint in testing.

10. Refrigerant Temperature and Pressure Instrumentation Locations

In the June 2021 RFI, DOE requested comment on changes between AHRI 1250–2020 and AHRI 1250–2009 which may impact the determination of AWEF or increase the testing burden. 86 FR 32332, 32336. In response to this request AHRI, Lennox, and Hussmann stated that the test set-up for DX Dual instrumentation method for testing dedicated condensing units alone has changed, represented by Figure C1 in AHRI 1250–2009, and the new Figure C2 in AHRI 1250–2020. The commenters stated that this changes the location of the instrumentation for pressure and temperature measurement. Additionally, they stated that the new method removes the alternative location of the second mass flow meter and claim that both sets of changes necessitate changes in lab test stands. Further, the commenters claimed that AHRI 1250–2020 added a change to the refrigeration capacity calculation for dedicated condensing units, whereby the enthalpy representing the refrigerant at the evaporator exit condition has changed such that it is based on a pressure corresponding to a dew point 2 °F higher than at the condensing unit inlet and a superheat of 6.5 °F. (Lennox, No. 9 at p. 3; AHRI, No. 11 at p. 5; Hussmann, No. 18 at p. 7) The same group of commentors stated these locations are now different than those specified for matched pair testing, and the DX Calibrated Box method. *Id.*

DOE notes first that AHRI 1250–2009 does not provide a test method for dedicated condensing units tested alone, other than incorporating by reference ASHRAE 23–2005 (*see* Section C12 of AHRI 1250–2009 appendix C). ASHRAE 23 calls for calculating capacity by multiplying the refrigerant mass flow rate by the difference in enthalpies. However, the current DOE test procedure clarifies which values of pressure and temperature are used to determine the enthalpies to use for this capacity calculation—this is specified in section 3.4.2.1 of subpart R, appendix C. The section indicates that, for enthalpy leaving the unit cooler, the calculation uses a pressure corresponding to a dew point temperature of 25 °F and a temperature of 35 °F for coolers, and a dew point of –20 °F and temperature of –14 °F for freezers. These dew points are identical to the dew points specified in AHRI 1250–2020.[59] The temperatures represent superheat levels equal to 10 °F for coolers and 6 °F for freezers, which are different than the 6.5 °F specified in Section C7.5.2 of AHRI 1250–2020. Section 3.4.2.1 of subpart R, appendix C, also indicates that in the current DOE test procedure, the measured enthalpy at the condensing unit exit shall be used as the enthalpy entering the unit cooler. This is consistent with Figure C2 and Section C7.5.1.1.2 of AHRI 1250–2020. Thus, the only difference in AHRI 1250–2020 affecting the dedicated condensing unit efficiency calculations is the change in specified superheat, and there is no effective difference in the location of required pressure and temperature measurements. DOE will address the calculation change and other test procedure changes that can alter the measurement in an energy conservation standards rulemaking.

The comments of AHRI, Lennox, and Hussmann also address the test burden of not allowing the use of the alternative second location of the mass flow meter. (AHRI, No. 11 at pp. 5–6; Lennox, No. 9 at p. 3; Hussmann, No. 18 at p. 7 The comments provided no indication that use of a mass flow meter in the suction line should not be allowed. Hence, DOE proposes to clarify that the location of the second mass flow meter in the suction line would still be allowed. This proposal would eliminate the potential costs associated with Figure C2's suggestion that use of a suction line mass flow meter is not allowed.

Issue 29: DOE requests comment on its proposal to clarify that the second mass flow measurement for the DX Dual Instrumentation method may be in the suction line upstream of the inlet to the condensing unit, as shown in Figure C1 of AHRI 1250–2009.

11. Updates to Default Values for Unit Cooler Parameters

For dedicated condensing units tested alone, the current DOE test procedure calculates on-cycle evaporator fan power based on the cooling capacity of the condensing unit. This is necessary as a dedicated condensing unit tested alone will have no measured value for evaporator fan power. The on-cycle evaporator fan power is set equal to a fraction of the gross cooling capacity. The fraction is specified by a coefficient of .013 for medium temperature coolers and a coefficient of .016 for low temperature coolers. These coefficients were a product of the 2016 rulemaking negotiations. As discussed in section III.B.3.c, Sections 7.9.1 and 7.9.2 of AHRI 1250–2020 add new equations to calculate on-cycle evaporator fan power when testing a dedicated condensing unit alone. These equations are different from those in the current test procedure at subpart R, appendix C. The equations in AHRI 1250–2020 are split based on low versus medium temperature dedicated condensing units, and the capacity of the dedicated condensing units. Those units over 50,000 Btu/h have one equation and those under 50,000 Btu/h that capacity have another, resulting in 4 equations total. These equations are based on more test data and analysis than those currently in subpart R, appendix C. DOE has tentatively determined that these equations would be more representative, and do not pose a greater test burden. Therefore, DOE proposes to adopt the calculations for on-cycle evaporator fan

[59] For example, for coolers, Tables 12 and 13 of AHRI 1250–2020 require that CDU suction dew point be 23 °F, while section C7.5.2 indicates that the enthalpy to use in the calculation of capacity shall be for a pressure corresponding to dew point 2 °F higher than for the recorded pressure at the inlet of the dedicated condensing unit.

power for dedicated condensing units tested alone in AHRI 1250–2020.

Issue 30: DOE requests comment on its proposal to adopt the calculations for evaporator fan power in AHRI 1250–2020.

12. Calculations and Rounding

To ensure greater test procedure consistency, DOE is proposing to include rounding requirements for AWEF and capacity in the newly proposed appendix C1. DOE notes that AHRI 1250–2020 does not include requirements for rounding these values. DOE recognizes that the manner in which values are rounded can affect the resulting capacity and AWEF values. To ensure consistency in the manner in which capacity and AWEF values are calculated, DOE is proposing that raw measured data would be used in all capacity and AWEF calculations. DOE's current standards specify a minimum AWEF value in Btu/(W–h) to the hundredths place; therefore, DOE is proposing that AWEF values would be rounded to the nearest 0.05 Btu/(W–h). To round capacity, DOE is proposing to round to the nearest multiple as specified in Table III.14. The proposed capacity bins and multiples are consistent with other HVAC test procedures.[60]

TABLE III.14—REFRIGERATION CAPACITY RATING RANGES AND THEIR ROUNDING MULTIPLES

Refrigeration capacity ratings, 1,000 Btu/h	Multiples, Btu/h
<20	100
≥20 and <38	200
≥38 and <65	500
≥65	1,000

Issue 31: DOE requests comment on its proposal for rounding AWEF to the nearest 0.05 Btu/(W-h) and rounding capacity values to the nearest multiple as presented in Table III.14.

H. Alternative Efficiency Determination Methods

Pursuant to the requirements of 10 CFR 429.70, DOE may permit use of an alternative efficiency determination method (''AEDM'') in lieu of testing equipment for which testing burden may be considerable and for which that equipment's energy efficiency performance may be well predicted by such alternative methods. Although specific requirements vary by product or equipment, use of an AEDM entails development of a mathematical model that estimates energy efficiency or energy consumption characteristics of the basic model, as would be measured by the applicable DOE test procedure. The AEDM must be based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data. A manufacturer must perform validation of an AEDM by demonstrating that the performance, as predicted by the AEDM, is in agreement with the performance as measured by actual testing in accordance with the applicable DOE test procedure. The validation procedure and requirements, including the statistical tolerance, number of basic models, and number of units tested vary by product or equipment.

Once developed, an AEDM may be used to rate and certify the performance of untested basic models in lieu of physical testing. However, use of an AEDM for any basic model is always at the option of the manufacturer. One potential advantage of AEDM use is that it may free a manufacturer from the burden of physical testing. One potential risk is that the AEDM may not perfectly predict performance, and the manufacturer could be found responsible for having an invalid rating for the equipment in question or for having distributed a noncompliant basic model. The manufacturer, by using an AEDM, bears the responsibility and risk of the validity of the ratings. For walk-ins, DOE currently permits the use of AEDMs for refrigeration systems only. 10 CFR 429.70(f).

The following sections discuss DOE's proposal to allow walk-in door manufacturers to use AEDMs to rate both display and non-display doors, as well as proposed updates to the current AEDM provisions for refrigeration systems.

1. Doors

DOE did not adopt provisions allowing for the use of AEDMs for walk-in doors in the May 2014 rule because DOE found that the modeling techniques approved for use in the NFRC 100 test procedure (incorporated by reference at 10 CFR 431.303) made a parallel AEDM provision for walk-in doors unnecessary. 79 FR 27388, 27394. Consistent with DOE's proposal to remove reference to NFRC 100 (and thus the computational method) for determining U-factor of doors, DOE is proposing to allow the use of AEDMs to determine the represented value of energy consumption of walk-in doors at 10 CFR 429.53(a)(3). Correspondingly, DOE is proposing to expand the AEDM provisions in 10 CFR 429.70(f) to apply to walk-in doors. DOE is proposing to include a 5 percent individual model tolerance, which aligns with the individual model tolerance applicable to walk-in refrigeration systems, to validate the energy consumption result of an AEDM with the appendix A test result at 10 CFR 429.70(f)(2)(ii). DOE also proposes that an AEDM for doors may not simulate or model components of the door that are not required to be tested by the DOE test procedure. If the test results used to validate the AEDM are for the U-factor test of the door, the AEDM must estimate the daily energy consumption—specifically, the conduction thermal load, and the direct and indirect electrical energy consumption, by using the nominal values (*e.g.,* EER values used for coolers and freezers, PTO values) and calculation procedure specified in the DOE test procedure. Additionally, DOE is proposing to include walk-in door validation classes at 10 CFR 429.70(f)(2)(iv) and to require that two basic models per validation class be tested using the proposed test procedure in appendix A, which is consistent with the number of basic models required to be tested per validation class for walk-in refrigeration systems. Lastly, DOE is proposing to include a 5 percent tolerance applicable to the maximum daily energy consumption metric for AEDM verification testing at 10 CFR 429.70(f)(5)(vi), which aligns with the tolerance applicable to AWEF of walk-in refrigeration systems.

Issue 32: DOE seeks comment on its proposal to allow for the use of AEDMs to determine the energy consumption rating of walk-in doors. DOE requests specific feedback on the proposed 5 percent model tolerance for validating an AEDM, the proposed validation classes and number of basic models required to be tested per validation class, and the proposed 5 percent tolerance on the result from a DOE AEDM verification test.

2. Refrigeration Systems

In the May 2014 final rule, DOE established that AEDMs can be used by manufacturers of refrigeration systems, once certain qualifications are met, to certify compliance and report ratings. 79 FR 27388, 27389. That rule established a uniform, systematic, and fair approach to the use of these types of modeling techniques that has enabled DOE to ensure that products in the marketplace are correctly rated—irrespective of whether they are subject to actual physical testing or are rated using

[60] A version of Table III.9 can be found in AHRI Standard 390 I–P (2021) ''Performance Rating of Single-packaged Vertical Air-Conditioners and Heat Pumps.''

modeling—without unnecessarily burdening regulated entities. *Id.*

A minimum of two distinct models must be tested to validate an AEDM for each validation class. The May 2014 final rule established the following AEDM validation classes for walk-ins:

- Dedicated condensing units, medium temperature, indoor system;
- Dedicated condensing units, medium temperature, outdoor system;
- Dedicated condensing units, low temperature, indoor system;
- Dedicated condensing units, low temperature, outdoor system;
- Unit cooler connected to a muliplex condensing unit, medium temperature;
- Unit cooler connected to a multiplex condensing unit, low temperature;
- Medium temperature, indoor condensing unit;
- Medium temperature, outdoor condensing unit;
- Low temperature, indoor condensing unit;
- Low temperature, outdoor condensing unit.

See 79 FR 27388, 27411 (codified at 10 CFR 429.70(f)(5)(iv)).

In this NOPR, DOE is proposing new test procedures for single-packaged refrigeration systems, high-temperature refrigeration systems, and CO_2 unit coolers. Temperature has a significant impact on equipment performance; therefore, DOE is proposing to incorporate new AEDM validation classes for all high-temperature refrigeration systems (dedicated condensing units, single-packaged dedicated systems, and matched pair systems). Additionally, single-packaged units are expected to perform differently than dedicated condensing units under the proposed test procedure which incorporates thermal losses. Therefore, DOE proposes to create new validation classes for low-temperature, medium-temperature, and high-temperature single-packaged dedicated systems. To ensure that walk-in validation classes are consistent with DOE's current walk-in terminology, DOE proposes to rename the ''unit cooler connected to a multiplex condensing unit'' validation classes to ''unit cooler'' at either medium- or low-temperature; however, the AEDM requirements for theses classes remain the same. Finally, DOE proposes to remove the medium/low temperature indoor/outdoor condensing unit validation classes, as these are redundant with the medium/low temperature indoor/outdoor dedicated condensing unit validation classes.

As discussed, DOE proposes to reference in appendix C1 the methods of test for single-packaged dedicated systems in Section C9 of AHRI 1250–2020, with some modifications. Implementation of appendix C1, if finalized, would require that all AEDMs for single-packaged dedicated systems are amended to be consistent with the test procedure proposed in appendix C1.

In summary, DOE is proposing the following AEDM validation classes for walk-in refrigeration equipment:

- Dedicated Condensing Unit, Medium Temperature, Indoor System
- Dedicated Condensing Unit, Medium Temperature, Outdoor System
- Dedicated Condensing Unit, Low Temperature, Indoor System
- Dedicated Condensing Unit, Low Temperature, Outdoor System
- Single-packaged Dedicated System, High-temperature, Indoor System
- Single-packaged Dedicated System, High-temperature, Outdoor System
- Single-packaged Dedicated System, Medium Temperature, Indoor System
- Single-packaged Dedicated System, Medium Temperature, Outdoor System
- Single-packaged Dedicated System, Low Temperature, Indoor System
- Single-packaged Dedicated System, Low Temperature, Outdoor System
- Matched Pair, High-temperature, Indoor Condensing Unit
- Matched Pair, High-temperature, Outdoor Condensing Unit
- Matched Pair, Medium Temperature, Indoor Condensing Unit
- Matched Pair, Medium Temperature, Outdoor Condensing Unit
- Matched Pair, Low Temperature, Indoor Condensing Unit
- Matched Pair, Low Temperature, Outdoor Condensing Unit
- Unit Cooler, High-temperature
- Unit Cooler, Medium Temperature
- Unit Cooler, Low Temperature

DOE would maintain its provision that outdoor models that are within a given validation class may be used to determine represented values for the corresponding indoor class, and additional validation testing is not required. For example, two dedicated condensing unit, medium temperature, outdoor systems may be used to validate an AEDM for both the ''Dedicated Condensing Unit, Medium Temperature, Outdoor System'' class and the ''Dedicated Condensing Units, Medium Temperature, Indoor System'' class. If indoor models that fall within a given validation class are tested and used to validate an indoor AEDM, they may only be used for that validation class.

DOE is proposing no additional modifications to the provisions within 10 CFR 429.70(f).

Issue 33: DOE seeks comment on its proposal to modify and extend its AEDM validation classes for refrigeration systems, consistent with the test procedure revisions discussed in this document.

I. Sampling Plan for Enforcement Testing

When DOE conducts enforcement testing of equipment, DOE uses one of the enforcement sampling plans in appendix A or B to subpart C of 10 CFR part 429 to calculate upper control limits and lower control limits around the standard value based on the standard deviation of the test sample. These statistics are applied to the test results in the sample to determine compliance or non-compliance. DOE uses appendix B to subpart C of 10 CFR part 429 to assess compliance for walk-in refrigeration systems, which is specifically intended for use for covered equipment and certain low-volume covered products. 10 CFR 429.110(e)(2). DOE does not specifically call out which appendix in subpart C of 10 CFR part 429 it uses for determination of compliance for walk-in doors or walk-in panels. In an Enforcement NOPR published on August 31, 2020 (''August 2020 Enforcement NOPR''), DOE proposed to add walk-in cooler and freezer doors and panels to the list of equipment subject to the low-volume enforcement sampling procedures in appendix B to subpart C of 10 CFR part 429. 85 FR 53691, 53696. DOE noted that this equipment is not currently included within DOE's list because when the current regulations were drafted, walk-in doors and walk-in panels did not have applicable performance standards, only design standards, and therefore sampling provisions were not necessary at the time. *Id.* DOE did not receive any comments in response to this proposal in the August 2020 Enforcement NOPR. DOE is therefore proposing in this document to include walk-in doors and walk-in panels in the list of low-volume products 10 CFR 429.110(e)(2).

Issue 34: DOE requests comment on its proposal to apply the low-volume sampling procedures in appendix B of subpart C of 10 CFR part 429 to walk-in doors and panels.

J. Test Procedure Costs and Impact

EPCA requires that test procedures proposed by DOE be reasonably designed to produce test results which reflect energy efficiency and energy use of a type of industrial equipment during a representative average use cycle and not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) The following sections discuss DOE's evaluation of the estimated costs and savings associated with the amendments proposed in this NOPR. The following sections outline the potential costs and savings differentiated by WICF component: Doors, panels, and refrigeration systems.

1. Doors

In this NOPR, DOE proposes the following amendments to the test procedures for walk-in cooler and freezer doors:

1. Referencing NFRC 102–2020 for the determination of U-factor;
2. Including AEDM [61] provisions for manufacturers to alternately determine the total energy consumption of display and non-display doors;
3. Providing additional detail for determining the area used to convert U-factor into conduction load, A_s, to differentiate it from the area used to determine compliance with the standards, A_{dd} or A_{nd}; and
4. Specifying a PTO value of 97 percent for door motors.

Items 1 and 3, referencing NFRC 102–2020 and additional detail on the area used to convert U-factor into a conduction load, improves the consistency, reproducibility, and representativeness of test procedure results. Item 2, including AEDM provisions, intends to provide manufacturers with the flexibility to use an alternative method that gives the best agreement for their doors. Item 4, by proposing to include a PTO value of 97 percent, intends to provide a more representative and consistent means for comparison of walk-in door performance for doors with motors.

DOE has tentatively determined that these proposed amendments would improve the representativeness, accuracy, and reproducibility of the test results, and would not be unduly burdensome for door manufacturers to conduct. DOE has also tentatively determined that these proposed amendments would not increase testing costs per basic model relative to the current DOE test procedure in appendix A, which DOE estimates to be $10,000 for third-party labs to determine energy consumption of a walk-in door, including physical U-factor testing per NFRC 102–2020.[62] DOE has tentatively determined that manufacturers would not be required to redesign any of the covered equipment or change how the equipment is manufactured, solely as result of the proposed amendments, if finalized.

The cost impact to manufacturers as a result of the reference to NFRC 102–2020 and inclusion of AEDM provisions is dependent on the agreement between tested and simulated values as specified in Section 4.7.1 of NFRC 100 [63] as referenced in the current test procedure. For manufacturers of doors that have been able to achieve the specified agreement between U-factors simulated using the method in NFRC 100 and U-factors tested using NFRC 102, manufacturers would be able to continue using the simulation method in NFRC 100, provided that the simulation method also meets the basic requirements proposed for an AEDM in 10 CFR 429.53 and 10 CFR 429.70(f).

For manufacturers of doors that have not been able to achieve the specified agreement between U-factors simulated using the method in NFRC 100 and U-factors tested using NFRC 102, DOE estimates that the test burden would decrease. Under the current requirements, manufacturers may be required to determine U-factor through physical testing of every basic model. If the proposed test procedure were to be adopted, manufacturers who would have otherwise been required to physically test every walk-in door basic model could develop an AEDM for rating their basic models of walk-in doors consistent with the proposed provisions in 10 CFR 429.53 and 10 CFR 429.70(f). DOE estimates the per-manufacturer cost to develop and validate an AEDM for a single validation class of walk-in doors to be $11,100. DOE estimates an additional cost to determine energy consumption of a walk-in door using an AEDM to be $46 per basic model.[64]

DOE expects that the additional detail provided for determining the area used to convert U-factor into conduction load, A_s, would either result in a reduced energy consumption or have no impact. To the extent that this change to the test procedure would amend the energy consumption attributable to a door, such changes would either not change the calculated energy consumption or result in a lower energy consumption value as compared to how manufacturers may currently be rating given that the current test procedure does not provide specific details on measurement of A_{dd} or A_{nd}. As such, DOE expects that manufacturers would be able to rely on data generated under the current test procedure. While manufacturers must submit a report annually to certify a basic model's represented values, basic models do not need to be retested annually. The initial test results used to generate a certified rating for a basic model remain valid as long as the basic model has not been modified from the tested design in a way that makes it less efficient or more consumptive, which would require a change to the certified rating. If a manufacturer has modified a basic model in a way that makes it more efficient or less consumptive, new testing is only required if the manufacturer wishes to make claims of the new, more efficient rating.[65]

For doors without motors, DOE has tentatively concluded that the proposed test procedure would not change energy consumption ratings, and therefore would not require re-rating solely as result of DOE's adoption of this proposed amendment to the test procedure. Therefore, DOE has determined the proposed amendments either decrease or result in no additional testing costs to manufacturers of walk-in doors.

To the extent that changes to the test procedure would amend the energy consumption attributable to a door motor, such changes would either not change the calculated energy consumption or result in a lower energy consumption value as compared to the currently granted waivers addressing door motors. As such, DOE expects that manufacturers would be able to rely on data generated under the current test procedure and current waivers. While manufacturers must submit a report annually to certify a basic model's represented values, basic models do not

[61] As already noted elsewhere in this document, an AEDM is a computer modeling or mathematical tool that predicts the performance of non-tested basic models. These computer modeling and mathematical tools, when properly developed, can provide a means to predict the energy usage or efficiency characteristics of a basic model of a given covered product or equipment and reduce the burden and cost associated with testing.

[62] DOE estimates the cost of one test to determine energy consumption of a walk-in door, including one physical U-factor test per NFRC 102–2020 to be $5,000. Per the sampling requirements specified at 10 CFR 429.53(a)(3)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[63] Section 4.7.1 of NFRC 100 requires that the accepted difference between the tested U-factor and the simulated U-factor be (a) 0.03 Btu/(h-ft2 °F) for simulated U-factors that are 0.3 Btu/(h-ft²-°F) or less, or (b) 10 percent of the simulated U-factor for simulated U-factors greater than 0.3 Btu/(h-ft²-°F). This agreement must match for the baseline product in a product line. Per NFRC 100, the baseline product is the individual product selected for validation; it is not synonymous with ''basic model'' as defined in 10 CFR 431.302.

[64] DOE estimated initial costs to validate an AEDM assuming 24 hours of general time to develop and validate an AEDM based on existing simulation tools. DOE estimated the cost of an engineering calibration technician fully burdened wage of $46 per hour plus the cost of third-party physical testing of two basic models per proposed validation class. DOE estimated the additional per basic model cost to determine efficiency using an AEDM assuming 1 hour per basic model at the cost of an engineering calibration technician wage of $46 per hour.

[65] See guidance issued by DOE at: *www1.eere.energy.gov/buildings/appliance_standards/pdfs/cert_faq_2012-04-17.pdf.*

need to be retested annually. The initial test results used to generate a certified rating for a basic model remain valid as long as the basic model has not been modified from the tested design in a way that makes it less efficient or more consumptive, which would require a change to the certified rating. If a manufacturer has modified a basic model in a way that makes it more efficient or less consumptive, new testing is only required if the manufacturer wishes to make claims of the new, more efficient rating.[66]

Issue 35: DOE requests comment on its tentative understanding of the impact of the test procedure proposals for appendix A in this NOPR—specifically, whether the proposed test procedure amendments, if finalized, would either not impact or decrease the testing burden for walk-in door manufacturers when compared to the current DOE test procedure in appendix A.

2. Panels

In this NOPR, DOE proposes to amend the existing test procedure in appendix B for measuring the R-value of insulation of panels by:

1. Incorporating by reference the updated version of the applicable industry test method, ASTM C518–17;
2. Including provisions specific to measurement of test specimen and total insulation thickness; and
3. Providing guidance on determining the parallelism and flatness of the test specimen.

Item 1 incorporates by reference the most up to date version of the industry standards currently referenced in the DOE test procedure. Items 2 and 3 include additional instructions intended to improve consistency and reproducibility of test procedure results. DOE has tentatively determined that these proposed amendments would improve the accuracy and reproducibility of the test results and would not be unduly burdensome for manufacturers to conduct, nor would they be expected to increase the testing burden.

DOE expects that the proposed test procedure in appendix B for measuring the R-value of insulation would not increase testing costs per basic model relative to the current DOE test procedure, which DOE estimates to be $1,200 for third-party lab testing.[67] Additionally, DOE has tentatively determined that the proposed test procedure in appendix B would not result in manufacturers having to redesign any of the covered equipment or change how the equipment is manufactured. Further DOE has tentatively determined that, if finalized, the proposed amendments would not impact the utility of the equipment.

Issue 36: DOE requests comment on its tentative understanding of the impact of the test procedure proposals for appendix B in this NOPR—specifically, that the proposed test procedure amendments, if finalized, would not increase testing burden on panel manufacturers when compared to the current DOE test procedure in appendix B.

3. Refrigeration Systems

In this NOPR, DOE proposes certain changes to subpart R, appendix C, that DOE has tentatively determined would improve the accuracy and reproducibility of the test results and would not be unduly burdensome for manufacturers to conduct. DOE has tentatively determined that these proposed changes would not impact testing cost. Additionally, the proposed amended subpart R, appendix C, measuring AWEF per AHRI 1250–2009, does not contain any changes that would require retesting or rerating if it were to be adopted. DOE's tentative assessment of the impacts of the proposed amendments of subpart R, appendix C, to include new test procedures for high-temperature refrigeration systems and CO_2 unit coolers are discussed in more detail below.

DOE also proposes to adopt certain changes in the newly proposed appendix C1 that would amend the existing test procedure for walk-in coolers and freezers by:

1. Expanding the off-cycle refrigeration system power measurements;
2. Adding methods of test for single-packaged dedicated systems; and
3. Including a method for testing ducted systems.

DOE has tentatively determined that these proposed amendments would improve the representativeness, accuracy, and reproducibility of the test results, and would not be unduly burdensome for manufacturers to conduct. DOE has also tentatively determined that these proposed amendments would impact testing costs by equipment type. DOE does not anticipate that the remainder of the amendments proposed in this NOPR would impact test costs or test burden.

DOE estimates third-party test costs for testing to the current DOE test procedure to be:

- $10,000 for outdoor low-temperature and medium-temperature dedicated condensing units tested alone
- $6,500 for indoor low temperature and medium temperature dedicated condensing units tested alone
- $6,500 for low-temperature unit coolers tested alone
- $6,000 for medium-temperature unit coolers tested alone
- $10,000 for single-packaged dedicated systems
- $10,000 for high-temperature matched pairs

As discussed previously in section III.G.1 of this document, DOE is proposing to adopt off-cycle test provisions in AHRI 1250–2020 for walk-in cooler and freezer refrigeration systems. The current test procedure requires off-cycle power to be measured at the 95 °F ambient condition. The proposed test procedure requires off-cycle to be measured at 95 °F, 59 °F, and 35 °F ambient conditions for outdoor dedicated condensing units, outdoor matched pair systems, and outdoor dedicated systems. The matched pair and single-packaged dedicated systems include high-temperature refrigeration systems. When the waivers for these high-temperature refrigeration systems were granted, only one off-cycle test was required; therefore, manufacturers with waivers would be required to conduct additional testing as compared to the alternate test procedure currently required. DOE estimates that measuring off-cycle power at these additional ambient conditions may increase per-unit third-party lab test cost by $1,000 per unit to a total cost of $11,000 per unit for outdoor dedicated condensing units, outdoor matched pair systems, and outdoor single-packaged dedicated systems.

Manufacturers are not required to perform laboratory testing on all basic models. In accordance with 10 CFR 429.53, WICF refrigeration system manufacturers may elect to use AEDMs. DOE estimates the per-manufacturer cost to develop and validate an AEDM for outdoor dedicated condensing units and outdoor matched pair systems to be $24,580.[68] DOE estimates an additional

[66] See guidance issued by DOE at: *www1.eere.energy.gov/buildings/appliance_standards/pdfs/cert_faq_2012-04-17.pdf.*

[67] DOE estimates the cost of one test to determine R-value to be $600. Per the sampling requirements specified at 10 CFR 429.53(a)(3)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[68] Outdoor single-packaged systems are also impacted by the proposed adoption of AHRI 1250–2020 single-packaged test procedure for walk-in cooler and freezer refrigeration systems. The combined potential cost increase for outdoor single-packaged systems is presented in the next paragraph.

cost of approximately $46 per basic model[69] for determining energy efficiency of a given basic model using the validated AEDM.

As discussed previously in section III.G.2, DOE is proposing to adopt the single-packaged dedicated system test procedure for walk-ins in AHRI 1250–2020. The proposed procedure requires air enthalpy tests to be used as the primary test method. In the current test procedure, single-packaged dedicated systems use refrigerant enthalpy as the primary test method. DOE does not estimate a difference in physical testing costs between air and refrigerant enthalpy testing of single-packaged units. DOE estimates the per-unit third-party lab test cost to be $11,000 for outdoor single-packaged units and $6,500 for indoor single-packaged units. However, should a manufacturer choose to use an AEDM, they may incur additional costs regarding the development and validation of new AEDMs for single-packaged dedicated systems. DOE estimates the per-manufacturer cost to develop and validate an AEDM to be $24,580 for outdoor single-packaged units and $15,580 for indoor single-packaged units. DOE estimates an additional cost of approximately $46 per basic model[70] for determining energy efficiency using the validated AEDM.

As discussed in sections III.F.6 and III.G.6, DOE is proposing test procedures for CO_2 unit coolers and high-temperature refrigeration systems. DOE tentatively estimates that the average third-party lab per unit test cost would be $11,000 for a high-temperature matched pair or single-packaged system, $6,000 for a high-temperature unit cooler tested alone, $6,500 for a low temperature CO_2 unit cooler, and $6,000 for a medium temperature CO_2 unit cooler. As discussed previously, DOE has granted waivers to certain manufacturers for both high-temperature refrigeration systems and CO_2 unit coolers. The test procedures proposed in this NOPR are consistent with the alternate test procedures included in the granted waivers. For those manufacturers who have been granted a test procedure waiver for this equipment, DOE expects that there would be no additional test burden. However, DOE expects that there would be additional testing costs for any manufacturers of these products who have not submitted or been granted a test procedure waiver at the time this proposed test procedure is finalized. Such companies may incur an additional per unit test cost of:

• $11,000 for a high-temperature matched pair or single-packaged system;
• $6,000 for a high-temperature unit cooler tested alone;
• $6,500 for a low temperature CO_2 unit cooler tested alone; and
• $6,000 for a medium temperature CO_2 unit cooler tested alone.

Issue 37: DOE requests comment on its tentative understanding of the impact of the test procedure proposals for refrigeration systems—specifically, whether DOE's initial conclusion that the proposed DOE test procedure amendments, if finalized, would increase testing burden.

K. Compliance Date and Waivers

EPCA prescribes that, if DOE amends a test procedure, all representations of energy efficiency and energy use, including those made on marketing materials and product labels, must be made in accordance with that amended test procedure, beginning 180 days after publication of such a test procedure final rule in the **Federal Register**. (42 U.S.C. 6314(d)(1)) To the extent the modified test procedure proposed in this document is required only for the evaluation and issuance of updated efficiency standards, use of the modified test procedure, if finalized, would not be required until the implementation date of updated standards. 10 CFR 431.4; section 8(e) of appendix A 10 CFR part 430 subpart C.

If DOE were to publish an amended test procedure, EPCA provides an allowance for individual manufacturers to petition DOE for an extension of the 180-day period if the manufacturer may experience undue hardship in meeting the deadline. (42 U.S.C. 6314(d)(2)) To receive such an extension, petitions must be filed with DOE no later than 60 days before the end of the 180-day period and must detail how the manufacturer will experience undue hardship. *Id.*

Upon the compliance date of any provisions of an amended test procedure, any waivers that are currently in effect pertaining to issues addressed by such provisions are terminated. 10 CFR 431.401(h)(3). Recipients of any such waivers would be required to test the products subject to the waiver according to the amended test procedure as of the compliance date of the amended test procedure. The amendments proposed in this document pertain to issues addressed by waivers and interim waivers granted to the manufacturers listed in Table III.15. The proposed amendments also address issues identified in a pending waiver for RSG (Case No. 2022–004).[71]

TABLE III.15—MANUFACTURERS GRANTED WAIVERS AND INTERIM WAIVERS

Manufacturer	Subject	Case No.	Relevant test procedure	Proposed test procedure compliance date
Jamison Door Company	PTO for Door Motors	2017–009	Appendix A	180 days after test procedure final rule publication.
HH Technologies	PTO for Door Motors	2018–001	Appendix A	180 days after test procedure final rule publication.
Senneca Holdings	PTO for Door Motors	2020–002	Appendix A	180 days after test procedure final rule publication.
Hercules	PTO for Door Motors	2020–013	Appendix A	180 days after test procedure final rule publication.

[69] DOE estimated initial costs to validate an AEDM assuming 40 hours of general time to develop an AEDM based on existing simulation tools and 16 hours to validate two basic models within that AEDM at the cost of an engineering calibration technician fully burdened wage of $46 per hour plus the cost of third-party physical testing of two units per validation class (as required in 10 CFR 429.70(c)(2)(iv)). DOE estimated the additional per basic model cost to determine efficiency using an AEDM assuming 1 hour per basic model at the cost of an engineering calibration technician wage of $46 per hour.

[70] DOE estimated initial costs to validate an AEDM assuming 40 hours of general time to develop an AEDM based on existing simulation tools and 16 hours to validate two basic models within that AEDM at the cost of an engineering calibration technician fully burdened wage of $46 per hour plus the cost of third-party physical testing of two units per validation class (as required in 10 CFR 429.70(c)(2)(iv)). DOE estimated the additional per basic model cost to determine efficiency using an AEDM assuming 1 hour per basic model at the cost of an engineering calibration technician wage of $46 per hour.

[71] The RSG waiver docket can be found at *www.regulations.gov/docket/EERE-2022-BT-WAV-0010.*

TABLE III.15—MANUFACTURERS GRANTED WAIVERS AND INTERIM WAIVERS—Continued

Manufacturer	Subject	Case No.	Relevant test procedure	Proposed test procedure compliance date
HTPG	CO_2 Unit Coolers	2020–009	Appendix C	180 days after test procedure final rule publication.
Hussmann	CO_2 Unit Coolers	2020–010	Appendix C	180 days after test procedure final rule publication.
Keeprite	CO_2 Unit Coolers	2020–014	Appendix C	180 days after test procedure final rule publication.
RefPlus, Inc	CO_2 Unit Coolers	2021–006	Appendix C	180 days after test procedure final rule publication.
RSG	Multi-Circuit Single-Package Dedicated Systems.	2022–004	Appendix C	180 days after test procedure final rule publication.
Store It Cold	Single-Package Dedicated Systems.	2018–002	Appendix C1	Compliance date of updated standards.
CellarPro	Wine Cellar Refrigeration Systems.	2019–009	Appendix C1	Compliance date of updated standards.
Air Innovations	Wine Cellar Refrigeration Systems.	2019–010	Appendix C1	Compliance date of updated standards.
Vinotheque	Wine Cellar Refrigeration Systems.	2019–011	Appendix C1	Compliance date of updated standards.
Vinotemp	Wine Cellar Refrigeration Systems.	2020–005	Appendix C1	Compliance date of updated standards.
LRC Coil	Wine Cellar Refrigeration Systems.	2020–024	Appendix C1	Compliance date of updated standards.

L. Organizational Changes

DOE is also proposing a number of non-substantive organizational changes. As discussed previously, DOE is proposing to reorganize appendices A and B so that they are easier for stakeholders to follow as a step-by-step test procedure. Additionally, DOE is proposing to remove the specifications at 10 CFR 429.53(a)(2)(i) regarding specific test procedure provisions and instead include these provisions in the uniform test method section at 10 CFR 431.304. The intent of this proposed change is to move provisions of the applicable test procedure to the appropriate place in subpart R, rather than keeping them under the provisions for determining represented values for certification. However, DOE is proposing to keep the additional detail regarding the represented values of various configurations of refrigeration systems (*e.g.,* outdoor and indoor dedicated condensing units, matched refrigeration systems, etc.) at 10 CFR 429.53(a)(2)(i).

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866 and 13563

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review,'' 76 FR 3821 (Jan. 21, 2011), requires agencies, to the extent permitted by law, to (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this proposed regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit ''significant regulatory actions'' to OIRA for review. OIRA has determined that this proposed regulatory action does not constitute a ''significant regulatory action'' under section 3(f) of E.O. 12866. Accordingly, this action was not submitted to OIRA for review under E.O. 12866.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (''IRFA'') for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (Aug. 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website: *www.energy.gov/gc/office-general-counsel.*

The following sections detail DOE's IRFA for this test procedure proposed rulemaking.

1. Description of Why Action Is Being Considered

The Energy Policy and Conservation Act, as amended (''EPCA''),[72] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part C [73] of EPCA, added by Public Law 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This covered equipment includes walk-in coolers and walk-in freezers, the subject of this document. (42 U.S.C. 6311(1)(G)) DOE is publishing this NOPR in satisfaction of the 7-year review requirement specified in EPCA. (42 U.S.C. 6314(a)(1))

2. Objective of, and Legal Basis for, Rule

The Energy Policy and Conservation Act, as amended (''EPCA''),[74] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part C [75] of EPCA, added by Public Law 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This covered equipment includes walk-in coolers and walk-in freezers, the subject of this document. (42 U.S.C. 6311(1)(G))

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use or estimated annual operating cost of a given type of covered equipment during a representative average use cycle and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment including WICFs, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 614(a)(1)(A))

3. Description and Estimate of Small Entities Regulated

For manufacturers of WICFs, the Small Business Administration (''SBA'') has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. *See* 13 CFR part 121. The equipment covered by this rule are classified under North American Industry Classification System (''NAICS'') code 333415,[76] ''Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing.'' In 13 CFR 121.201, the SBA sets a threshold of 1,250 employees or fewer for an entity to be considered as a small business for this category.

DOE reviewed the test procedures proposed in this NOPR under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE used publicly available information to identify potential small businesses that manufacture WICFs covered in this rulemaking. DOE's analysis relied on publicly available databases to identify potential small businesses that manufacture equipment covered in this rulemaking. DOE utilized the DOE's Certification Compliance Database (''CCD'') [77] and the California Energy Commission's Modernized Appliance Efficiency Database System (''MAEDbS'') [78] in identifying manufacturers. DOE also used subscription-based business information tools to determine headcount and revenue of the small businesses.

Using these data sources, DOE identified 79 original equipment manufacturers (''OEMs'') of WICFs that could be potentially affected by this rulemaking. DOE screened out companies that do not meet the definition of a ''small business'' or are foreign-owned and operated. Of these 79 OEMs, 60 are small, domestic manufacturers. DOE notes that some manufacturers may produce more than one of the principal components of WICFs: Panels, doors, and refrigeration systems. Eighteen of the small, domestic OEMs manufacture refrigeration systems; 38 of the small, domestic OEMs manufacture panels; and 43 of the small, domestic OEMs manufacture doors. To better reflect the impact on manufacturers, DOE evaluated the impacts of test procedure changes to panels, doors, and refrigeration systems separately.

Of these small businesses, not all were impacted by the proposed changes. The following section further details the impact to manufacturers by principal component and proposed test procedure amendment.

Issue 38: DOE invites comment on the number of small, domestic OEMs producing the three principal components of WICFs: Panels, doors, and refrigeration systems.

4. Description and Estimate of Compliance Requirements

The potential regulatory costs of the proposed test procedure are differentiated by WICF component: Panels, doors, and refrigeration systems. The following sub-sections outline these changes and potential burden.

a. Doors

In this NOPR, DOE proposes the following amendments to the test procedures for walk-in cooler and freezer doors:

1. Referencing NFRC 102–2020 for the determination of U-factor;
2. Including AEDM [79] provisions for manufacturers to alternately determine the total energy consumption of display and non-display doors;
3. Providing additional detail for determining the area used to convert U-factor into conduction load, A_s, to differentiate it from the area used to determine compliance with the standards, A_{dd} or A_{nd}; and
4. Specifying a percent time off (''PTO'') value of 97 percent for door motors.

Items 1 and 3, referencing NFRC 102–2020 and additional detail on the area used to convert U-factor into a

[72] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020).

[73] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

[74] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020).

[75] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

[76] The size standards are listed by NAICS code and industry description and are available at: *www.sba.gov/document/support--table-size-standards* (Last accessed on November 1, 2021).

[77] Certified equipment in the CCD are listed by product class and can be accessed at *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (Last accessed July 15th, 2021).

[78] MAEDbS can be accessed at *www.cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx* (Last accessed Nov. 1, 2021).

[79] An AEDM is a computer modeling or mathematical tool that predicts the performance of non-tested basic models. These computer modeling and mathematical tools, when properly developed, can provide a means to predict the energy usage or efficiency characteristics of a basic model of a given covered product or equipment and reduce the burden and cost associated with testing.

conduction load, would improve the consistency, reproducibility, and representativeness of test procedure results. Item 2, including AEDM provisions, would provide manufacturers with the flexibility to use an alternative method that gives the best agreement for their doors. Item 4, specifying a PTO value of 97 percent for door motors, would provide a more representative and consistent means for comparison of walk-in door performance for doors with motors. DOE has tentatively determined that these proposed amendments as a whole would improve the representativeness, accuracy, and reproducibility of the test results, and would not be unduly burdensome for door manufacturers to conduct. DOE has also tentatively determined that these proposed amendments would not increase physical testing costs per basic model relative to the current DOE test procedure in appendix A, which DOE estimates to be $10,000 for third-party labs to determine energy consumption of a walk-in door, including physical U-factor testing per NFRC 102–2020.[80] DOE has tentatively determined that manufacturers would not be required redesign any of the covered equipment or change how the equipment is manufactured, solely as result of the proposed amendments.

DOE is also proposing to permit manufacturers to use AEDMs. Using AEDMs when evaluating the energy efficiency of their equipment may enable some manufacturers to reduce costs to rate models. AEDMs can require an upfront investment but lower overall testing costs. The cost impact to manufacturers as result of the reference to NFRC 102–2020 and inclusion of AEDM provisions is dependent on the agreement specified in Section 4.7.1 of NFRC 100 [81] between U-factors simulated using the method in NFRC 100 and U-factors tested using NFRC 102. For manufacturers of doors that have been able to achieve the specified agreement between U-factors simulated using the method in NFRC 100 and U-factors tested using NFRC 102, manufacturers would be able to continue using the simulation method in NFRC 100, provided that the simulation method also meets the basic requirements proposed for an AEDM in 10 CFR 429.53 and 10 CFR 429.70(f).

For manufacturers of doors that have not been able to achieve the specified agreement between U-factors simulated using the method in NFRC 100 and U-factors tested using NFRC 102, DOE estimates that the test burden could decrease. Under the current requirements, manufacturers may be required to physically test every model to meet the basic model definition since these models are highly customizable. If the proposed test procedure is adopted, manufacturers who would otherwise physically test every walk-in door basic model could develop an AEDM for rating. DOE estimates the per-manufacturer cost to develop and validate an AEDM for a single validation class of walk-in doors to be $11,100. DOE estimates the cost to determine energy consumption of a walk-in door using an AEDM to be $46 per basic model.

DOE expects that the additional detail provided for determining the area used to convert U-factor into conduction load, A_s, would either result in a reduced energy consumption or have no impact. To the extent that this change to the test procedure would amend the energy consumption attributable to a door, such changes would either not change the calculated energy consumption or result in a lower energy consumption value as compared to how manufacturers may currently be rating. As such, DOE expects that manufacturers would be able to rely on data generated under the current test procedure. While manufacturers must submit a report annually to certify a basic model's represented values, basic models do not need to be retested annually. The initial test results used to generate a certified rating for a basic model remain valid as long as the basic model has not been modified from the tested design in a way that makes it less efficient or more consumptive, which would require a change to the certified rating. If a manufacturer has modified a basic model in a way that makes it more efficient or less consumptive, new testing is only required if the manufacturer wishes to make claims of the new, more efficient rating.[82]

For doors without motors, DOE has tentatively concluded that the proposed test procedure would not change energy consumption ratings, and therefore would not require re-rating as a result this proposed test procedure. Therefore, DOE has determined the proposed amendments would either decrease or result in no additional testing costs to small business manufacturers of walk-in doors.

To the extent that changes to the test procedure would amend the energy consumption attributable to a door motor, such changes would either not change the calculated energy consumption or result in a lower energy consumption value as compared to the currently granted waivers addressing door motors. As such, DOE expects that manufacturers would be able to rely on data generated under the current test procedure and current waivers. While manufacturers must submit a report annually to certify a basic model's represented values, basic models would not need to be retested annually. The initial test results used to generate a certified rating for a basic model would remain valid as long as the basic model has not been modified from the tested design in a way that makes it less efficient or more consumptive, which would require a change to the certified rating. If a manufacturer has modified a basic model in a way that makes it more efficient or less consumptive, new testing would be required only if the manufacturer wishes to make claims of the new, more efficient rating.[83]

Issue 39: DOE requests comment on its cost estimate of impacts on small, domestic OEMs of doors.

b. Panels

DOE proposes to amend the existing test procedure in appendix B for measuring the R-value of insulation of walk-in panels by:

1. Incorporating by reference the updated version of the applicable industry test method, ASTM C518–17;
2. Including provisions specific to the measurement of test specimen and total insulation thickness; and
3. Providing guidance on determining the parallelism and flatness of the test specimen.

Item 1 incorporates by reference the most up to date version of the industry standards currently referenced in the DOE test procedure. Items 2 and 3 includes additional instructions that would improve the consistency and reproducibility of test procedure results.

[80] DOE estimates the cost of one test to determine energy consumption of a walk-in door, including one physical U-factor test per NFRC 102–2020, to be $5,000. Per the sampling requirements specified at 10 CFR 429.53(a)(3)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[81] Section 4.7.1 of NFRC 100 requires that the accepted difference between the tested U-factor and the simulated U-factor be (a) 0.03 Btu/(h-ft^2-°F) for simulated U-factors that are 0.3 Btu/(h-ft^2-°F) or less, or 10 percent of the simulated U-factor for simulated U-factors greater than 0.3 Btu/(h-ft^2-°F). This agreement must match for the baseline product in a product line. Per NFRC 100, the baseline product is the individual product selected for validation; it is not synonymous with ''basic model'' as defined in 10 CFR 431.302.

[82] *See* guidance issued by DOE at: *www1.eere.energy.gov/buildings/appliance_standards/pdfs/cert_faq_2012-04-17.pdf.*

[83] *See* guidance issued by DOE at: *www1.eere.energy.gov/buildings/appliance_standards/pdfs/cert_faq_2012-04-17.pdf.*

DOE has tentatively determined that these proposed amendments would improve the accuracy and reproducibility of the test results and would not be unduly burdensome for manufacturers to conduct, nor would they be expected to increase the testing burden.

DOE expects that the proposed test procedure in appendix B for the measuring R-value of insulation would not increase testing costs per basic model relative to the current DOE test procedure, which DOE estimates to be $1,200 for third-party lab testing.[84] Additionally, DOE has tentatively determined that manufacturers would not be required to redesign any of the covered equipment or change how the equipment is manufactured, solely as result of the proposed amendments. Further, DOE has tentatively determined that the proposed amendments would not impact the utility of the equipment.

DOE has tentatively concluded that the proposed test procedure would not change efficiency ratings for walk-in panels, and therefore would not require re-rating as result of DOE's adoption of this proposed amendment to the test procedure. Therefore, DOE has determined the proposed amendments would not add any additional testing costs to small business manufacturers of walk-in doors.

Issue 40: DOE requests comment on its cost estimate of impacts on small, domestic OEMs of panels.

c. Refrigeration Systems

In this NOPR, DOE proposes certain changes to subpart R, appendix C, that DOE has tentatively determined would improve the accuracy and reproducibility of the test results and would not be unduly burdensome for manufacturers to conduct. DOE has tentatively determined that these proposed changes would not impact testing cost. Additionally, the proposed amended subpart R, appendix C, measuring AWEF per AHRI 1250–2009, does not contain any changes that would require retesting or rerating if it were to be adopted.

DOE also proposes to adopt through incorporations by reference certain provisions of AHRI 1250–2020 in appendix C1 that would amend the existing test procedure for walk-in cooler and freezer refrigeration systems. Additionally, DOE proposes amendments to the current DOE test procedure to accommodate high-temperature refrigeration systems and CO_2 unit coolers. A summary of the proposed changes are as follows:

1. Expanding the off-cycle refrigeration system power measurements;
2. Adding air enthalpy methods for single-packaged dedicated systems;
3. Including new test procedures for high-temperature refrigeration systems; and
4. Including new test procedures for CO_2 unit coolers.

DOE has tentatively determined that these proposed amendments would improve the representativeness, accuracy, and reproducibility of the test results, and would not be unduly burdensome for manufacturers to conduct. DOE has also tentatively determined that these proposed amendments may impact testing costs. The following paragraphs outline the proposed changes and the potential costs to manufacturers. Because DOE's proposal of off-cycle refrigeration power measurements and single-packaged dedicated system air enthalpy test methods requirements impact both high-temperature and CO_2 units, all potential cost impacts to high-temperature and CO_2 units are discussed separately in the third and fourth sections.

(1) Small Business Impacts as a Result of Off-Cycle Refrigeration System Power Requirements

DOE is proposing to adopt the off-cycle testing for walk-ins in AHRI 1250–2020. The current test procedure requires off-cycle power to be measured at the 95 °F ambient condition. The proposed test procedure requires off-cycle to be measured at 95 °F, 59 °F, and 35 °F ambient conditions for outdoor dedicated condensing units, outdoor matched pair systems, and outdoor single-packaged dedicated systems. These proposed amendments would not increase testing costs or require manufacturers to re-rate models, as DOE energy conservation standards do not currently require off-cycle requirements to be measured at 95 °F, 59 °F, and 35 °F ambient conditions for outdoor dedicated condensing units, outdoor matched pair systems, and outdoor single-packaged systems. However, should DOE adopt energy conservation standards that require these off-cycle requirements, DOE estimates that measuring off-cycle power at these additional ambient conditions may increase per-unit third-party lab test cost by $1,000 per unit to a total cost of $11,000 per unit for outdoor dedicated condensing units and outdoor matched pair systems.[85] The physical testing cost, according to the proposed amendments, would be $22,000 per basic model for outdoor dedicated condensing units and outdoor matched pair systems.[86]

However, manufacturers are not required to perform laboratory testing on all basic models. In accordance with 10 CFR 429.53, WICF refrigeration system manufacturers may elect to use AEDMs. DOE estimates the per-manufacturer cost to develop and validate an AEDM for outdoor dedicated condensing units and outdoor matched pair systems to be $24,580 per validation class. DOE estimates an additional cost of approximately $46 per basic model[87] for determining energy efficiency using the validated AEDM.

DOE estimates the range of potential costs for the five small OEMs that manufacture outdoor dedicated condensing units and outdoor matched pair systems. When developing cost estimates for the small OEMs, DOE considers the cost to update the existing AEDM simulation tool, the costs to validate the AEDM through physical testing, and the cost to rate basic models using the AEDM. DOE assumes a high-cost scenario where manufacturers would be required to develop AEDMs for six validation classes.

DOE estimates the impacts based on basic model counts and company revenue. Table IV.1 summarizes DOE's estimates for the five identified small businesses. On average, testing costs represent less than 1 percent of annual revenue for a typical small business.

[84] DOE estimates the cost of one test to determine R-value to be $600. Per the sampling requirements specified at 10 CFR 429.53(a)(3)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[85] Outdoor single-packaged systems are also impacted by the proposed adoption of AHRI 1250–2020 single-packaged test procedure for walk-in cooler and freezer refrigeration systems. The combined potential cost increase for outdoor single-packaged systems is presented in the following section.

[86] The cost to test one unit is $11,000. Per the sampling requirements specified at 10 CFR 429.53(a)(2)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[87] DOE estimated initial costs to validate an AEDM assuming 40 hours of general time to develop an AEDM based on existing simulation tools and 16 hours to validate two basic models within that AEDM at the cost of an engineering calibration technician fully burdened wage of $46 per hour plus the cost of third-party physical testing of two units per validation class (as required in 10 CFR 429.70(c)(2)(iv)). DOE estimated the additional per basic model cost to determine efficiency using an AEDM assuming 1 hour per basic model at the cost of an engineering calibration technician wage of $46 per hour.

TABLE IV.1—ESTIMATED SMALL BUSINESS RE-RATING COSTS (2022$) AS A RESULT OF OFF-CYCLE REFRIGERATION SYSTEM POWER REQUIREMENTS

Manufacturer	Re-rating estimate ($mm)	Annual revenue estimate ($mm)	Percent of revenue (%)
Manufacturer A	0.151	12	1.25
Manufacturer B	0.148	19	0.78
Manufacturer C	0.214	77	0.28
Manufacturer D	0.148	86	0.17
Manufacturer E	0.159	147	0.10

(2) Small Business Impacts as a Result of Requiring Single-Packaged Dedicated Systems To Test Using Air Enthalpy Methods

DOE is also proposing to adopt the single-packaged dedicated system test procedure in AHRI 1250–2020 for walk-in cooler and freezer refrigeration systems. The proposed procedure requires air enthalpy tests to be used as the primary test method. In the current test procedure, single-packaged dedicated systems use refrigerant enthalpy as the primary test method. DOE estimates no difference in costs between air and refrigerant enthalpy testing of single-packaged dedicated systems. DOE estimates the per-unit third-party lab test cost to be $11,000 for outdoor single-packaged dedicated systems and $6,500 for indoor single-packaged dedicated systems. The physical testing cost, according to the proposed amendments, would be $22,000 per basic model for outdoor single-packaged dedicated systems and $13,000 per basic model for indoor package systems.[88] However, manufacturers of single-packaged dedicated systems may elect to use AEDMs. DOE estimates the per-manufacturer cost to develop and validate an AEDM per validation class to be $24,580 for outdoor single-packaged dedicated systems and $15,580 for indoor single-packaged dedicated systems. DOE estimates an additional cost of approximately $46 per basic model [89] for determining energy efficiency using the validated AEDM.

DOE estimated the range of potential costs for the two domestic, small OEMs that manufacture single-packaged dedicated systems. When developing cost estimates for the small OEMs, DOE considered the cost to update the existing AEDM simulation tool, the costs to validate the AEDM through physical testing, and the cost to rate basic models using the AEDM.

Both small businesses manufacture indoor and outdoor, low and medium temperature, single-packaged dedicated systems. One small business manufactures 28 basic models of single-packaged dedicated systems with an estimated annual revenue of $19 million. Therefore, DOE estimates that the associated re-rating costs for this manufacturer to be approximately $81,650 when making use of AEDMs. The cost for this manufacturer represents less than 1 percent of annual revenue.

The second small business manufactures 38 basic models of single-packaged dedicated systems with an estimated annual revenue of $147 million. Therefore, DOE estimates that the associated re-rating costs for this manufacturer to be approximately $82,100 when making use of AEDMs. The cost for this manufacturer represents less than 1 percent of annual revenue.

(3) Small Business Impacts as a Result of New Test Procedures for High-Temperature Refrigeration Systems

DOE is proposing test procedures for high-temperature refrigeration systems. DOE has granted waivers to certain manufacturers for high-temperature refrigeration systems. The test procedures proposed in this NOPR are consistent with the alternate test procedures included in the granted waivers, excluding the changes discussed previously about off-cycle power measurements. For those manufacturers who have been granted a test procedure waiver for this equipment, DOE expects the only test burden incurred would be that related to off-cycle requirements. However, DOE expects that there would be additional testing costs for any manufacturers of these products who have not submitted or been granted a test procedure waiver at the time this proposed test procedure is finalized.

For manufacturers that have been granted waivers, DOE estimates that measuring off-cycle power at these additional ambient conditions may increase per-unit third-party lab test cost by $1,000 to a total per-unit cost of $11,000 for high-temperature outdoor dedicated condensing units, outdoor matched pair systems, and outdoor single-packaged dedicated systems. The physical testing cost, according to the proposed amendments, would be $22,000 per basic model for outdoor dedicated condensing units and outdoor matched pair systems.[90]

However, manufacturers are not required to perform laboratory testing on all basic models. In accordance with 10 CFR 429.53, WICF refrigeration system manufacturers may elect to use AEDMs. DOE estimates the per-manufacturer cost to develop and validate an AEDM for outdoor dedicated condensing units and outdoor matched pair systems to be $24,580 per validation class. DOE estimates an additional cost of approximately $46 per basic model [91] for determining energy efficiency using the validated AEDM.

[88] Per the sampling requirements specified at 10 CFR 429.53(a)(2)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[89] DOE estimated initial costs to validate an AEDM assuming 40 hours of general time to develop an AEDM based on existing simulation tools and 16 hours to validate two basic models within that AEDM at the cost of an engineering calibration technician fully burdened wage of $46 per hour plus the cost of third-party physical testing of two units per validation class (as required in 10 CFR 429.70(c)(2)(iv)). DOE estimated the additional per basic model cost to determine efficiency using an AEDM assuming 1 hour per basic model at the cost of an engineering calibration technician wage of $46 per hour.

[90] Per the sampling requirements specified at 10 CFR 429.53(a)(2)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[91] DOE estimated initial costs to validate an AEDM assuming 40 hours of general time to develop an AEDM based on existing simulation tools and 16 hours to validate two basic models within that AEDM at the cost of an engineering calibration technician fully burdened wage of $46 per hour plus the cost of third-party physical testing of two units per validation class (as required in 10 CFR 429.70(c)(2)(iv)). DOE estimated the additional per basic model cost to determine efficiency using an AEDM assuming 1 hour per basic model at the cost of an engineering calibration technician wage of $46 per hour.

DOE estimated the potential costs to manufacturers of high-temperature units as a result of off-cycle requirements using an AEDM. Specifically, DOE estimated the range of potential costs for the five identified domestic, small OEMs that manufacture high-temperature units. When developing cost estimates for the small OEMs, DOE considers the cost to develop the AEDM simulation tool, the costs to validate the AEDM through physical testing, and the cost to rate basic models using the AEDM. DOE assumes a scenario where manufacturers would be required to develop AEDMs for three validation classes.

DOE estimated the impacts based on basic model counts and company revenue. Table IV.2 summarizes DOE's estimates for the five identified small businesses. On average, testing costs represent approximately 1.5 percent of annual revenue for a typical small business.

TABLE IV.2—ESTIMATED SMALL BUSINESS RE-RATING COSTS (2022$) FOR HIGH-TEMPERATURE REFRIGERATION SYSTEMS

Manufacturer	Re-rating estimate ($mm)	Annual revenue estimate ($mm)	Percent of revenue (%)
Manufacturer A	0.075	2.1	3.57
Manufacturer B	0.074	3.6	2.06
Manufacturer C	0.074	8.9	0.84
Manufacturer D	0.076	11	0.70
Manufacturer E	0.075	14	0.53

For manufacturers that have not been granted waivers, manufacturers of high-temperature equipment may incur first-time rating expenses. DOE estimates these manufacturers may incur rating expenses up to $22,000 per basic model for a high-temperature matched pair, $22,000 per basic model for a single-packaged dedicated system, and $12,000 per basic model for a high-temperature unit cooler.[92]

(4) Small Business Impacts as a Result of New Test Procedures for CO_2 Unit Coolers

Lastly, DOE is proposing test procedures for CO_2 unit coolers. DOE has granted waivers to certain manufacturers for CO_2 unit coolers. In this proposal, DOE is proposing that CO_2 refrigeration systems, as DOE proposed to define in section III.A.2.h of this NOPR, meet the definition of a walk-in, but that the DOE test procedure is applicable only to single-packaged dedicated and to unit cooler variants of CO_2 refrigeration systems. All CO_2 refrigerant waiver petitions DOE has thus far received address unit coolers. 86 FR 32332, 32346.

The test procedures proposed in this NOPR are consistent with the alternate test procedures included in the granted waivers. For those manufacturers who have been granted a test procedure waiver for this equipment, DOE expects no change in test burden. However, DOE expects that there would be additional testing costs for any manufacturers of these products who have not submitted or been granted a test procedure waiver at the time this proposed test procedure is finalized. This additional cost is partially offset because, without a method of test, manufacturers of these products would not be able to sell them in the U.S. since there would be no way of certifying their energy use as required EPCA.

For manufacturers that have not been granted waivers, manufacturers of CO_2 equipment may incur first-time rating expenses. DOE estimates these manufacturers may incur rating expenses up to $13,000 per-unit for a low temperature CO_2 unit cooler and $12,000 per-unit for a medium temperature CO_2 unit cooler.[93] However, manufacturers of CO_2 unit coolers may choose to utilize an AEDM. Furthermore, AEDM unit cooler validation classes do not distinguish between CO_2 unit coolers and non-CO_2 unit coolers. Therefore, manufacturers of CO_2 unit coolers may use the same validation classes as non-CO_2 unit coolers.

Issue 41: DOE requests comment on its cost estimate of impacts on small, domestic OEMs of refrigeration systems.

5. Duplication, Overlap, and Conflict With Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being considered in this document.

6. Significant Alternatives to the Rule

DOE proposes to reduce burden on manufacturers, including small businesses, by allowing AEDMs in lieu of physically testing all basic models. The use of an AEDM is less costly than physical testing WICF components. For doors, DOE's proposed inclusion of AEDM provisions would allow manufacturers to develop an AEDM for rating their models. Without an AEDM, DOE estimates physical testing would cost door manufacturers $10,000 per basic model. With the use of an AEDM, DOE estimates the costs of $11,100 to develop and validate a single validation class plus an additional $46 per basic model yielding savings to manufacturers that produce more than one basic model of door. For refrigeration systems, DOE estimates $24,580 at the high-end of the range to develop and validate an AEDM with an additional cost of $46 per basic model. With a high-end cost of approximately $22,000 per basic model to physically test refrigeration models, manufacturers of three or more basic models could yield cost savings.

Additional compliance flexibilities may be available through other means. For example, manufacturers subject to DOE's energy efficiency standards may apply to DOE's Office of Hearings and Appeals for exception relief under certain circumstances. Manufacturers should refer to 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of walk-ins must certify to DOE that their products comply with any applicable energy conservation standards. To certify

[92] Per the sampling requirements specified at 10 CFR 429.53(a)(2)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

[93] Per the sampling requirements specified at 10 CFR 429.53(a)(2)(ii) and 10 CFR 429.11(b), manufacturers are required to test at least two units to determine the rating for a basic model, except where only one unit of the basic model is produced.

compliance, manufacturers must first obtain test data for their products according to the DOE test procedures, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including walk-ins. *See generally* 10 CFR part 429. The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by the Office of Management and Budget (''OMB'') under the Paperwork Reduction Act (''PRA''). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

DOE is not proposing to amend the certification or reporting requirements for walk-ins in this NOPR. Instead, DOE may consider proposals to amend the certification requirements and reporting for walk-ins under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910–1400 at that time, as necessary.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

In this NOPR, DOE proposes test procedure amendments that it expects would be used to develop and implement future energy conservation standards for walk-in coolers and freezers. DOE has determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*) and DOE's implementing regulations at 10 CFR part 1021. Specifically, DOE has tentatively determined that adopting test procedures for measuring energy efficiency of consumer products and industrial equipment is consistent with activities identified in 10 CFR part 1021, appendix A to subpart D, A5 and A6. *See also* 10 CFR 1021.410. DOE will complete its NEPA review before issuing the final rule.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (Aug. 4, 1999), imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the National Government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

Regarding the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' 61 FR 4729 (Feb. 7, 1996), imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. Section 3(b) of Executive Order 12988 specifically requires that executive agencies make every reasonable effort to ensure that the regulation (1) clearly specifies the preemptive effect, if any, (2) clearly specifies any effect on existing Federal law or regulation, (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction, (4) specifies the retroactive effect, if any, (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires executive agencies to review regulations in light of applicable standards in sections 3(a) and 3(b) to determine whether they are met, or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, the proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments, and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *energy.gov/gc/office-general-counsel.* DOE examined this proposed rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations

Act, 1999 (Pub. L. 105–277), requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This proposed rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), that this proposed regulation would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note), provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M–19–15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf.* DOE has reviewed this proposed rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OMB, a Statement of Energy Effects for any proposed significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgated or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

The proposed regulatory action to amend the test procedure for measuring the energy efficiency of walk-ins is not a significant regulatory action under Executive Order 12866. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as a significant energy action by the Administrator of OIRA. Therefore, it is not a significant energy action, and, accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under Section 32 of the Federal Energy Administration Act of 1974

Under section 301 of the Department of Energy Organization Act (Pub. L. 95–91; 42 U.S.C. 7101), DOE must comply with section 32 of the Federal Energy Administration Act of 1974, as amended by the Federal Energy Administration Authorization Act of 1977. (15 U.S.C. 788; ''FEAA'') Section 32 essentially provides in relevant part that, where a proposed rule authorizes or requires use of commercial standards, the notice of proposed rulemaking must inform the public of the use and background of such standards. In addition, section 32(c) requires DOE to consult with the Attorney General and the Chairman of the Federal Trade Commission (''FTC'') concerning the impact of the commercial or industry standards on competition.

The proposed modifications to the test procedure for walk-ins would incorporate testing methods contained in certain sections of the following commercial standards: NFRC 102–2020, ASTM C1199–14, ASTM C518–17, AHRI 1250–2020, ASHRAE 37–2009, AHRI 1250–2020, ANSI/ASHRAE 37–2009, and ANSI/ASHRAE 16–2016. DOE has evaluated these standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the FEAA (*i.e.,* whether they were developed in a manner that fully provides for public participation, comment, and review). DOE will consult with both the Attorney General and the Chairman of the FTC concerning the impact of these test procedures on competition, prior to prescribing a final rule.

M. Description of Materials Incorporated by Reference

In this NOPR, DOE proposes to incorporate by reference the following industry test standards into 10 CFR part 431:

(1) AHRI Standard 1250–2020, ''Standard for Performane Rating of Walk-in Coolers and Freezers,'' copyright 2020.

AHRI 1250–2020 is an industry-accepted test procedure for measuring the performance of walk-in cooler and walk-in freezer refrigeration systems. AHRI 1250–2020 is available on AHRI's website at *www.ahrinet.org/search-standards.*

(2) ANSI/ASHRAE Standard 16–2016, ''Method of Testing for Rating Room Air Conditioners, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps for Cooling and Heating Capacity,'' approved October 31, 2016.

ANSI/ASHRAE 16 is an industry-accepted test procedure for measuring cooling and heating capacity of room air conditioners, packaged terminal air conditioners, and packaged terminal heat pumps referenced by AHRI 1250–2020. ANSI/ASHRAE 16 includes test provisions related to the measuring of the capacity of single-packaged dedicated systems for the proposed appendix C1 test procedure. ANSI/ASHRAE 16 is available on ASHRAE's website at *www.ashrae.org.*

(3) ANSI/ASHRAE Standard 37–2009, ''Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment,'' approved June 24, 2009.

ANSI/ASHRAE 37 is an industry-accepted test procedure for testing and rating air-conditioning and heat pump equipment referenced by AHRI 1250–2020. ANSI/ASHRAE 37 includes test provisions related to the measuring of the capacity of single-packaged dedicated systems for the proposed appendix C1 test procedure. ANSI/ASHRAE 37 is available on ASHRAE's website at *www.ashrae.org.*

(4) ASTM C518–17, ''Standard Test Method for Steady state Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus,'' approved May 1, 2017.

ASTM C518–17 is an industry-accepted test procedure for measuring thermal transmission properties using a heat flow meter apparatus. ASTM C518–17 is available on ASTM's website at *www.astm.org.*

(5) ASTM C1199–14, ''Standard Test Method for Measuring the Steady state Thermal Transmittance of Fenestration Systems Using Hot Box Methods,'' approved February 1, 2014.

ASTM C1199–14 is an industry-accepted test procedure for measuring the steady state thermal transmittance of fenestration systems referenced by NFRC 102–2020. ASTM C1199–14 is available on ASTM's website at *www.astm.org.*

(6) NFRC 102–2020 [E0A0], ''Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.''

NFRC 102–2020 is an industry-accepted test procedure for measuring the steady state thermal transmittance of fenestration systems. NFRC 102–2020 is available on NFRC's website at *www.nfrc.org/.*

The following standards were approved on December 28, 2016, for IBR into the provisions where they appear in this document and no change in use is proposed: ANSI/AHRI Standard 420–2008, AHRI Standard 1250 (I–P)–2009, and ANSI/ASHRAE Standard 23.1–2010.

V. Public Participation

A. Participation in the Webinar

The time and date of the webinar are listed in the **DATES** section at the beginning of this document. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website: *www.energy.gov/eere/buildings/public-meetings-and-comment-deadlines.* Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has an interest in the topics addressed in this document, or who is representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the webinar. Such persons may submit to *ApplianceStandardsQuestions@ee.doe.gov.* Persons who wish to speak should include with their request a computer file in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format that briefly describes the nature of their interest in this proposed rulemaking and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

Persons requesting to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. DOE requests persons selected to make an oral presentation to submit an advance copy of their statements at least two weeks before the webinar. At its discretion, DOE may permit persons who cannot supply an advance copy of their statement to participate, if those persons have made advance alternative arrangements with the Building Technologies Office. As necessary, requests to give an oral presentation should ask for such alternative arrangements.

C. Conduct of the Webinar

DOE will designate a DOE official to preside at the webinar/public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the webinar/public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the webinar/public meeting and until the end of the comment period, interested parties may submit further comments on the proceedings and any aspect of the proposed rulemaking.

The webinar/public meeting will be conducted in an informal, conference style. DOE will present a general overview of the topics addressed in this proposed rulemaking, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this proposed rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will permit, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this proposed rulemaking. The official conducting the webinar/public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the procedures that may be needed for the proper conduct of the webinar/public meeting.

A transcript of the webinar/public meeting will be included in the docket, which can be viewed as described in the Docket section at the beginning of this proposed rule. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule no later than the date provided in the **DATES** section at the beginning of this proposed rule.[94] Interested parties may submit comments using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via www.regulations.gov. The *www.regulations.gov* web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment.

[94] DOE has historically provided a 75-day comment period for test procedure NOPRs pursuant to the North American Free Trade Agreement, U.S.-Canada-Mexico (''NAFTA''), Dec. 17, 1992, 32 I.L.M. 289 (1993); the North American Free Trade Agreement Implementation Act, Public Law 103–182, 107 Stat. 2057 (1993) (codified as amended at 10 U.S.C.A. 2576) (1993) (''NAFTA Implementation Act''); and Executive Order 12889, ''Implementation of the North American Free Trade Agreement,'' 58 FR 69681 (Dec. 30, 1993). However, on July 1, 2020, the Agreement between the United States of America, the United Mexican States, and the United Canadian States (''USMCA''), Nov. 30, 2018, 134 Stat. 11 (*i.e.,* the successor to NAFTA), went into effect, and Congress's action in replacing NAFTA through the USMCA Implementation Act, 19 U.S.C. 4501 *et seq.* (2020), implies the repeal of E.O. 12889 and its 75-day comment period requirement for technical regulations. Thus, the controlling laws are EPCA and the USMCA Implementation Act. Consistent with EPCA's public comment period requirements for consumer products, the USMCA only requires a minimum comment period of 60 days. Consequently, DOE now provides a 60-day public comment period for test procedure NOPRs.

Persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (''CBI'')). Comments submitted through *www.regulations.gov* cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through *www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that *www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email. Comments and documents submitted via email also will be posted to *www.regulations.gov.* If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information on a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. No faxes will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, written in English and free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well-marked copies: One copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked non-confidential with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

Issue 1: DOE requests comment on its proposed changes to the definition for walk-in cooler and walk-in freezer.

Issue 2: DOE requests feedback on the proposed changes to the definition of ''door'' and the newly proposed definition for ''door leaf.'' DOE also seeks comment on the newly proposed definitions for certain door opening characteristics: ''hinged vertical door,'' ''roll-up door,'' and ''sliding door.''

Issue 3: DOE requests comment on the proposed definition of ''ducted fan coil unit'' and on the proposed modification to the ''single-packaged dedicated system'' definition.

Issue 4: DOE requests comment on the proposed definition for multi-circuit single-packaged dedicated refrigeration systems.

Issue 5: DOE requests comment on the proposed definition for attached split system.

Issue 6: DOE requests comment on the proposed definition for detachable single-packaged dedicated system.

Issue 7: DOE requests comment on the proposed definition of CO_2 unit coolers. DOE also requests comment on whether any distinguishing features of CO_2 unit coolers exist that could reliably be used as an alternative approach that can differentiate them from those unit coolers intended for use with conventional refrigerants.

Issue 8: DOE requests comment on the proposed definition for hot gas defrost. Specifically, DOE requests comment on if this proposed definition is sufficient to identify which equipment is sold with hot gas defrost capability installed and which is not.

Issue 9: DOE requests feedback on the proposed provisions relating to test specimen and total insulation thickness and test specimen preparation prior to conducting the ASTM C518–17 test.

Issue 10: DOE requests feedback on the proposed provisions relating to determining parallelism and flatness of the test specimen.

Issue 11: DOE seeks comment on other comparable data or studies of aging of foam panels that are representative of the foam insulation, blowing agents, and panel construction currently used in the manufacture of walk-in panels. DOE also requests comment on whether manufacturers have been certifying R-value at time of manufacture or after a period of aging.

Issue 12: DOE requests comment on the proposed pretest coil inspection requirement. DOE requests comment on whether the proposed approach is inconsistent in any way with the way units under test are used to assist in chamber conditioning by testing facilities, and if so, in what way are the proposals inconsistent, and how could they be changed to align with this practice.

Issue 13: DOE requests comment on its proposal to require use of thermometer wells or sheathed sensors immersed in the refrigerant when measuring temperature at the liquid outlet of the condensing unit and to forego the requirement for this measurement technique for the suction line when testing a dedicated condensing unit alone.

Issue 14: DOE requests comment on its proposal to allow the use of two temperature measuring instruments, placed on the outside of refrigerant tubing that is less than or equal to ½-inch, for the measurement of refrigerant temperature where the current test procedure requirement is to use thermometer wells or a sheathed sensor immersed in the refrigerant.

Issue 15: DOE requests comment on its proposals discussed in this section regarding set up of walk-in refrigeration systems for testing to achieve manufacturer-specified conditions for superheat, subcooling, high-side temperature, pressure or saturation temperature, low-side temperature, pressure or saturation temperature, and refrigerant charge weight. Additionally, DOE requests comment on the proposed hierarchy presented in Table III.6, if a laboratory has confirmed that the unit is properly charged.

Issue 16: DOE requests comments on its proposal to clarify the location where the 3 °F subcooling requirement would apply and to require active cooling of the liquid line in order to achieve the required 3 °F subcooling at a refrigerant mass flow meter. DOE also seeks comment on its proposal to require, for matched pairs, adjustment of the measured unit cooler inlet temperature by the difference in temperatures measured upstream and downstream of the active cooling in order to calculate the inlet enthalpy in the capacity calculation.

Issue 17: DOE requests comment on the appropriateness of traditional refrigerant compressor EER values for use in CO_2 unit cooler AWEF calculations.

Issue 18: DOE requests comment on its proposals to adopt test procedure provisions for high-temperature unit coolers in appendices C and C1 of 10 CFR part 431, subpart R.

Issue 19: DOE requests comments on its proposals to align the test procedures for appendix C1 with AHRI 1250–2020, except for the use of off-cycle power measurements in the AWEF calculations for dedicated condensing units, matched pairs, or single-packaged dedicated systems intended for outdoor installation. DOE requests comments on its proposals for use in the AWEF calculations of the three sets of unit cooler and condensing unit off-cycle measurements made for outdoor refrigeration systems.

Issue 20: DOE requests comment on the proposed single-packaged refrigerant enthalpy test procedure for evaluating the performance of single-packaged dedicated systems.

Issue 21: DOE requests comment on testing detachable single-packaged dedicated systems using the test procedure for single-packaged dedicated systems.

Issue 22: DOE requests comment on its proposal that attached split systems be tested using refrigerant enthalpy methods.

Issue 23: DOE requests comment on provisions for setting ESP when testing ducted units.

Issue 24: DOE requests comments on its proposals for testing multiple-, variable-, and two-capacity dedicated condensing units tested alone. DOE specifically requests comments on (a) the expectation that a unit cooler with which such a condensing unit is paired in the field would have two-speed (or variable-speed) fans or be fitted with such fans during installation, (b) the proposed compressor operating levels to use for testing, (c) the proposed compressor operating level at which the unit cooler fan would be assumed to switch to half-speed, (d) the proposed targets for unit cooler exit and condensing unit inlet refrigerant temperatures and dew point target temperatures, and (e) the unit cooler half-fan-speed input wattage.

Issue 25: DOE requests comment on whether DOE should set the target test conditions using correlations for unit cooler and suction line response to part-load operation rather than the proposed tabular approach.

Issue 26: DOE requests comment on its proposal to include in its test procedures instructions for testing and determining representations for indoor matched pair and single-packaged dedicated systems.

Issue 27: DOE requests comment on its proposal to modify the approach for calculating intermediate-capacity EER for variable-speed refrigeration systems.

Issue 28: DOE requests comments on its proposals to address part-load testing for refrigeration systems with digital compressors.

Issue 29: DOE requests comment on its proposal to clarify that the second mass flow measurement for the DX Dual Instrumentation method may be in the suction line upstream of the inlet to the condensing unit, as shown in Figure C1 of AHRI 1250–2009.

Issue 30: DOE requests comment on its proposal to adopt the calculations for evaporator fan power in AHRI 1250–2020.

Issue 31: DOE requests comment on its proposal for rounding AWEF to the nearest 0.05 Btu/(W-h) and rounding capacity values to the nearest multiple as presented in Table III.14.

Issue 32: DOE seeks comment on its proposal to allow for the use of AEDMs to determine the energy consumption rating of walk-in doors. DOE requests specific feedback on the proposed 5 percent model tolerance for validating an AEDM, the proposed validation classes and number of basic models required to be tested per validation class, and the proposed 5 percent tolerance on the result from a DOE AEDM verification test.

Issue 33: DOE seeks comment on its proposal to modify and extend its AEDM validation classes for refrigeration systems, consistent with the test procedure revisions discussed in this document.

Issue 34: DOE requests comment on its proposal to apply the low-volume sampling procedures in appendix B of subpart C of 10 CFR part 429 to walk-in doors and panels.

Issue 35: DOE requests comment on its tentative understanding of the impact of the test procedure proposals for appendix A in this NOPR—specifically, whether the proposed test procedure amendments, if finalized, would either not impact or decrease the testing burden for walk-in door manufacturers when compared to the current DOE test procedure in appendix A.

Issue 36: DOE requests comment on its tentative understanding of the impact of the test procedure proposals for appendix B in this NOPR—specifically, that the proposed test procedure amendments, if finalized, would not increase testing burden on panel manufacturers when compared to the current DOE test procedure in appendix B.

Issue 37: DOE requests comment on its tentative understanding of the impact of the test procedure proposals for refrigeration systems—specifically, whether DOE's initial conclusion that the proposed DOE test procedure amendments, if finalized, would increase testing burden.

Issue 38: DOE invites comment on the number of small, domestic OEMs producing the three principal components of WICFs: Panels, doors, and refrigeration systems.

Issue 39: DOE requests comment on its cost estimate of impacts on small, domestic OEMs of doors.

Issue 40: DOE requests comment on its cost estimate of impacts on small, domestic OEMs of panels.

Issue 41: DOE requests comment on its cost estimate of impacts on small, domestic OEMs of refrigeration systems.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and announcement of public webinar.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Reporting and recordkeeping requirements.

10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation test procedures, Incorporation by reference, and Reporting and recordkeeping requirements.

Signing Authority

This document of the Department of Energy was signed on March 18, 2022, by Kelly J. Speakes-Backman, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on March 23, 2022.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

For the reasons stated in the preamble, DOE is proposing to amend parts 429 and 431 of chapter II of title 10, Code of Federal Regulations as set forth below:

PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

■ 2. Amend § 429.53 by:

■ a. Revising paragraphs (a)(2)(i) and (a)(3); and

■ b. Adding paragraph (a)(4).

The revisions and addition read as follows:

§ 429.53 Walk-in coolers and walk-in freezers.

(a) * * *

(2) * * *

(i) *Applicable test procedure.* If the AWEF is determined by testing, test according to the applicable provisions of § 431.304(b) of this chapter with the equipment specific provisions in paragraphs (a)(2)(i)(A) through (D) of this section.

(A) *Dedicated condensing units.* Outdoor dedicated condensing refrigeration systems that are also designated for use in indoor applications must be tested and rated as both an outdoor dedicated condensing refrigeration system and an indoor dedicated refrigeration system.

(B) *Matched refrigeration systems.* A matched refrigeration system is not required to be rated if the constituent unit cooler(s) and dedicated condensing unit have been tested as specified in § 431.304(b)(4) of this chapter. However, if a manufacturer wishes to represent the efficiency of the matched refrigeration system as distinct from the efficiency of either constituent component, or if the manufacturer cannot rate one or both of the constituent components using the specified method, the manufacturer must test and rate the matched refrigeration system as specified in § 431.304(b)(4) of this chapter.

(C) *Detachable single-packaged dedicated systems.* Detachable single-packaged dedicated systems must be tested and rated as a single-packaged dedicated systems using the test procedure in § 431.304(b)(4) of this chapter.

(D) *Attached split systems.* Attached split systems must be tested and rated as dedicated condensing units and unit coolers using the test procedure in § 431.304(b)(4) of this chapter.

* * * * *

(3) For each basic model of walk-in cooler and walk-in freezer display and non-display door, the daily energy consumption must be determined by testing, in accordance with § 431.304 of this chapter and the provisions of this section, or by application of an alternative efficiency determination method (AEDM) that meets the requirements of § 429.70 and the provisions of this section.

(i) *Applicable test procedure.* Prior to [*180 days after publication of final rule*], use the test procedure for walk-ins as it appeared in 10 CFR part 431, subpart R, appendix A, revised as of January 1, 2021, to determine daily energy consumption. Beginning [*180 days after publication of final rule*], use the test procedure in part 431, subpart R, appendix A, of this chapter to determine daily energy consumption.

(ii) *Units to be tested.* For each basic model, a sample of sufficient size shall be randomly selected and tested to ensure that any represented value of daily energy consumption of a basic model or other measure of energy use for which consumers would favor lower values shall be greater than or equal to the higher of:

(A) The mean of the sample, where:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

And $\bar{x}$ is the sample mean, n is the number of samples, and x_i is the i^{th} sample; or,

(B) The upper 95 percent confidence limit (UCL) of the true mean divided by 1.05, where:

$$UCL = \bar{x} + t_{0.95}\frac{s}{\sqrt{n}}$$

And $\bar{x}$ is the sample mean, s is the sample standard deviation; n is the number of samples, and $t_{0.95}$ is the statistic for a 95% one-tailed confidence interval with n-1 degrees of freedom (from appendix A to this subpart).

(4) For each basic model of walk-in cooler and walk-in freezer panel and non-display door, the R-value must be determined by testing, in accordance with § 431.304 of this chapter and the provisions of this section.

(i) *Applicable test procedure.* Prior to [*date 180 days after publication of final rule*], use the test procedure for walk-ins as it appeared in 10 CFR part 431, subpart R, appendix B, revised as of January 1, 2021, to determine R-value. Beginning [*date 180 days after publication of final rule*], use the test procedure in part 431, subpart R, appendix B, of this chapter to determine R-value.

(ii) *Units to be tested.* For each basic model, a sample of sufficient size shall be randomly selected and tested to ensure that any represented value of R-value or other measure of efficiency of a basic model for which consumers would favor higher values shall be less than or equal to the lower of:

(A) The mean of the sample, where:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

And $\bar{x}$ is the sample mean, n is the number of samples, and x_i is the i^{th} sample; or,

(B) The lower 95 percent confidence limit (LCL) of the true mean divided by 0.95, where:

$$LCL = \bar{x} - t_{0.95}\frac{s}{\sqrt{n}}$$

And $\bar{x}$ is the sample mean, s is the sample standard deviation; n is the number of samples, and $t_{0.95}$ is the statistic for a 95% one-tailed confidence interval with n-1 degree of freedom (from appendix A to this subpart).

* * * * *

■ 3. Amend § 429.70 by:

■ a. Revising paragraphs (f) heading and (f)(2)(ii)(A) and (B);

■ b. Adding paragraph (f)(2)(ii)(C);

■ c. Removing the word ''and'' at the end of paragraphs (f)(2)(iii)(A) and (C);

■ d. Removing the period at the end of paragraph (f)(2)(iii)(D) and adding ''; and'' in its place;

■ e. Adding paragraph (f)(2)(iii)(E); and

■ f. Revising paragraphs (f)(2)(iv) and (f)(5)(vi).

The revisions and additions read as follows:

§ 429.70 Alternative methods for determining energy efficiency and energy use.

* * * * *

(f) *Alternative efficiency determination method (AEDM) for walk-in refrigeration systems and doors*— * * *

(2) * * *

(ii) * * *

(A) For refrigeration systems, which are subject to an energy efficiency metric, the predicted efficiency for each model calculated by applying the AEDM may not be more than five percent greater than the efficiency determined from the corresponding test of the model.

(B) For doors, which are subject to an energy consumption metric the predicted daily energy consumption for each model calculated by applying the AEDM may not be more than five percent less than the daily energy consumption determined from the corresponding test of the model.

(C) The predicted energy efficiency or energy consumption for each model calculated by applying the AEDM must meet or exceed the applicable Federal energy conservation standard.

(iii) * * *

(E) For rating doors, an AEDM may not simulate or model components of the door that are not required to be tested by the DOE test procedure. That is, if the test results used to validate the AEDM are for the U-factor test of the door, the AEDM must estimate the daily energy consumption, specifically the conduction thermal load, and the direct and indirect electrical energy consumption, using the nominal values and calculation procedure specified in the DOE test procedure.

(iv) *Walk-in coolers and freezers (WICF) validation classes*—(A) *Doors.*

TABLE 1 TO PARAGRAPH (f)(2)(iv)(A)

Validation class	Minimum number of distinct models that must be tested
Display Doors, Medium Temperature	2 Basic Models.
Display Doors, Low Temperature	2 Basic Models.
Non-display Doors, Medium Temperature	2 Basic Models.
Non-display Doors, Low Temperature	2 Basic Models.

(B) *Refrigeration systems.* (*1*) For representations made prior to the compliance date of revised energy conservation standards for walk-in cooler and walk-in freezer refrigeration systems, use the following validation classes.

TABLE 2 TO PARAGRAPH (f)(2)(iv)(B)(*1*)

Validation class	Minimum number of distinct models that must be tested
Dedicated Condensing, Medium Temperature, Matched Pair Indoor System	2 Basic Models.
Dedicated Condensing, Medium Temperature, Matched Pair Outdoor System.[1]	2 Basic Models.
Dedicated Condensing, Low Temperature, Matched Pair Indoor System	2 Basic Models.
Dedicated Condensing, Low Temperature, Matched Pair Outdoor System.[1]	2 Basic Models.
Unit Cooler, High-temperature	2 Basic Models.
Unit Cooler, Medium Temperature	2 Basic Models.
Unit Cooler, Low Temperature	2 Basic Models.
Medium Temperature, Indoor Condensing Unit	2 Basic Models.
Medium Temperature, Outdoor Condensing Unit.[1]	2 Basic Models.
Low Temperature, Indoor Condensing Unit	2 Basic Models.
Low Temperature, Outdoor Condensing Unit.[1]	2 Basic Models.

[1] AEDMs validated for an outdoor class by testing only outdoor models of that class may be used to determine representative values for the corresponding indoor class, and additional validation testing is not required. AEDMs validated only for a given indoor class by testing indoor models or a mix of indoor and outdoor models may not be used to determine representative values for the corresponding outdoor class.

(*2*) For representations made on or after the compliance date of revised energy conservation standards for walk-in cooler and walk-in freezer refrigeration systems, use the following validation classes.

TABLE 3 TO PARAGRAPH (f)(2)(iv)(B)(*2*)

Validation class	Minimum number of distinct models that must be tested
Dedicated Condensing Unit, Medium Temperature, Indoor System	2 Basic Models.
Dedicated Condensing Unit, Medium Temperature, Outdoor System.[1]	2 Basic Models.
Dedicated Condensing Unit, Low Temperature, Indoor System	2 Basic Models.
Dedicated Condensing Unit, Low Temperature, Outdoor System.[1]	2 Basic Models.
Single-packaged Dedicated Condensing, High-temperature, Indoor System	2 Basic Models.

TABLE 3 TO PARAGRAPH (f)(2)(iv)(B)(*2*)—Continued

Validation class	Minimum number of distinct models that must be tested
Single-packaged Dedicated Condensing, High-temperature, Outdoor System.[1]	2 Basic Models.
Single-packaged Dedicated Condensing, Medium Temperature, Indoor System	2 Basic Models.
Single-packaged Dedicated Condensing, Medium Temperature, Outdoor System.[1]	2 Basic Models.
Single-packaged Dedicated Condensing, Low Temperature, Indoor System	2 Basic Models.
Single-packaged Dedicated Condensing, Low Temperature, Indoor System.[1]	2 Basic Models.
Matched Pair, High-temperature, Indoor Condensing Unit	2 Basic Models.
Matched Pair, High-temperature, Outdoor Condensing Unit.[1]	2 Basic Models.
Matched Pair, Medium Temperature, Indoor Condensing Unit	2 Basic Models.
Matched Pair, Medium Temperature, Outdoor Condensing Unit.[1]	2 Basic Models.
Matched Pair, Low Temperature, Indoor Condensing Unit	2 Basic Models.
Matched Pair, Low Temperature, Outdoor Condensing Unit.[1]	2 Basic Models.
Unit Cooler, High-temperature	2 Basic Models.
Unit Cooler, Medium Temperature	2 Basic Models.
Unit Cooler, Low Temperature	2 Basic Models.

[1] AEDMs validated for an outdoor class by testing only outdoor models of that class may be used to determine representative values for the corresponding indoor class, and additional validation testing is not required. AEDMs validated only for a given indoor class by testing indoor models or a mix of indoor and outdoor models may not be used to determine representative values for the corresponding outdoor class.

* * * * *

(5) * * *

(vi) *Tolerances.* For efficiency metrics, the result from a DOE verification test must be greater than or equal to the certified rating × (1 − the applicable tolerance). For energy consumption metrics, the result from a DOE verification test must be less than or equal to the certified rating × (1 + the applicable tolerance).

TABLE 4 TO PARAGRAPH (f)(5)(vi)

Equipment	Metric	Applicable tolerance
Refrigeration systems (including components)	AWEF	5%
Doors	Daily Energy Consumption	5%

* * * * *

■ 4. Amend § 429.110 by revising paragraph (e)(2) to read as follows:

§ 429.110 Enforcement testing.

* * * * *

(e) * * *

(2) For automatic commercial ice makers; commercial refrigerators, freezers, and refrigerator-freezers; refrigerated bottled or canned vending machines; commercial air conditioners and heat pumps; commercial packaged boilers; commercial warm air furnaces; commercial water heating equipment; and walk-in cooler and walk-in freezer doors, panels, and refrigeration systems, DOE will use an initial sample size of not more than four units and follow the sampling plans in appendix B of this subpart (Sampling Plan for Enforcement Testing of Covered Equipment and Certain Low-Volume Covered Products).

* * * * *

■ 5. Amend § 429.134 by:

■ a. Adding paragraph (q) introductory text; and

■ b. Revising paragraphs (q)(2) and (4).

The addition and revisions read as follows:

§ 429.134 Product-specific enforcement provisions.

* * * * *

(q) * * * Prior to [*date 180 days after final rule publication*], the provisions in 10 CFR 429.134, revised as of January 1, 2021, are applicable. On and after [*date 180 days after final rule publication*], the provisions in paragraphs (q)(1) through (4) of this section apply.

* * * * *

(2) *Verification of refrigeration system net capacity.* The net capacity of the refrigeration system basic model will be measured pursuant to the test requirements of part 431, subpart R, appendix C, of this chapter for each unit tested on and after [*date 180 days after final rule publication*] but before the compliance date of revised energy conservation standards for walk-in cooler and walk-in freezer refrigeration systems. The net capacity of the refrigeration system basic model will be measured pursuant to the test requirements of part 431, subpart R, appendix C1, of this chapter for each unit tested on and after the compliance date of revised energy conservation standards for walk-in cooler and walk-in freezer refrigeration systems. The results of the measurement(s) will be averaged and compared to the value of net capacity certified by the manufacturer. The certified net capacity will be considered valid only if the average measured net capacity is within plus or minus five percent of the certified net capacity.

* * * * *

(4) *Verification of door electricity-consuming device power.* For each basic model of walk-in cooler and walk-in freezer door, DOE will calculate the door's energy consumption using the input power listed on the nameplate of each electricity-consuming device shipped with the door. If an electricity-consuming device shipped with a walk-in door does not have a nameplate or the nameplate does not list the device's input power, then DOE will use the device's rated input power included in the door's certification report. If the door is not certified or if the certification does not include a rated input power for an electricity-consuming device shipped with a walk-in door, DOE will use the measured input power. DOE also may validate the power listed on the nameplate or the rated input power by measuring it when

energized using a power supply that provides power within the allowable voltage range listed on the component nameplate or the door nameplate, whichever is available. If the measured input power is more than 10 percent higher than the input power listed on the nameplate or the rated input power, as appropriate, then the measured input power shall be used in the door's energy consumption calculation.

(i) For electricity-consuming devices with controls, the maximum input wattage observed while energizing the device and activating the control shall be considered the measured input power. For anti-sweat heaters that are controlled based on humidity levels, the control may be activated by increasing relative humidity in the region of the controls without damaging the sensor. For lighting fixtures that are controlled with motion sensors, the control may be activated by simulating motion in the vicinity of the sensor. Other kinds of controls may be activated based on the functions of their sensor.

(ii) [Reserved]

* * * * *

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 6. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

■ 7. Amend § 431.302 by:
■ a. Adding, in alphabetical order, definitions for ''Attached split system,'' ''CO_2 unit cooler,'' and ''Detachable single-packaged dedicated system'';
■ b. Revising the definition for ''Door'';
■ c. Adding, in alphabetical order, definitions for ''Door leaf,'' ''Door surface area,'' ''Ducted fan coil unit,'' ''High-temperature refrigeration system,'' ''Hinged vertical door,'' ''Hot gas defrost,'' ''Multi-circuit single-packaged dedicated system,'' ''Non-display door,'' and ''Roll-up door'';
■ d. Revising the definition of ''Single-packaged dedicated system'';
■ e. Adding, in alphabetical order, the definition for ''Sliding door''; and
■ f. Revising the definition of ''Walk-in cooler and walk-in freezer'';

The additions and revisions read as follows:

§ 431.302 Definitions concerning walk-in coolers and walk-in freezers.

* * * * *

Attached split system means a matched pair refrigeration system which is designed to be installed with the evaporator entirely inside the walk-in enclosure and the condenser entirely outside the walk-in enclosure, and the evaporator and condenser are permanently connected with structural members extending through the walk-in wall.

* * * * *

CO_2 *unit cooler* means a unit cooler that includes a nameplate listing only CO_2 as an approved refrigerant.

* * * * *

Detachable single-packaged dedicated system means a system consisting of a dedicated condensing unit and an insulated evaporator section in which the evaporator section is designed to be installed external to the walk-in enclosure and circulating air through the enclosure wall, and the condensing unit is designed to be installed either attached to the evaporator section or mounted remotely with a set of refrigerant lines connecting the two components.

* * * * *

Door means an assembly installed in an opening of an interior or exterior wall that is used to allow access or close off the opening and that is movable in a sliding, pivoting, hinged, or revolving manner of movement. For walk-in coolers and walk-in freezers, a door includes the frame (including mullions), the door leaf or multiple leaves (including glass) within the frame, and any other elements that form the assembly or part of its connection to the wall.

Door leaf means the pivoting, rolling, sliding, or swinging portion of a door.

Door surface area means the product of the height and width of a walk-in door measured external to the walk-in. The height and width dimensions shall be perpendicular to each other and parallel to the wall or panel of the walk-in to which the door is affixed. The height and width measurements extend to the edge of the frame and frame flange (as applicable) to which the door is affixed. The surface area of a display door is represented as A_{dd} and the surface area of a non-display door is represented as A_{nd}.

Ducted fan coil unit means an assembly, including means for forced air circulation capable of moving air against both internal and non-zero external flow resistance, and elements by which heat is transferred from air to refrigerant to cool the air, with provision for ducted installation.

* * * * *

High-temperature refrigeration system means a refrigeration system which is not designed to operate below 45 °F.

Hinged vertical door means a door with a leaf (or leaves) with a hinge (or hinges) connecting one vertical edge of the leaf (or leaves) to a frame or mullion of the door. This includes doors that swing open in one direction (*i.e.,* into or out of the walk-in) and free-swinging doors that open both into and out of the walk-in.

Hot gas defrost means a factory-installed system where refrigerant is used to transfer heat from ambient outside air, to the compressor, and/or a thermal storage component that stores heat when the compressor is running and uses this stored heat to defrost the evaporator coils.

* * * * *

Multi-circuit single-packaged dedicated system means a single-packaged dedicated system (as defined in this section) that contains two or more refrigeration circuits that refrigerate a single stream of circulated air.

Non-display door means a door that is not a display door.

* * * * *

Roll-up door means a door that bi-directionally rolls open and closed in a vertical and horizontal manner and includes vertical jamb tracks.

Single-packaged dedicated system means a refrigeration system (as defined in this section) that is a single-packaged assembly that includes one or more compressors, a condenser, a means for forced circulation of refrigerated air, and elements by which heat is transferred from air to refrigerant.

Sliding door means a door having one or more manually-operated or motorized leaves within a common frame that slide horizontally or vertically.

* * * * *

Walk-in cooler and walk-in freezer means an enclosed storage space including, but not limited to, panels, doors, and refrigeration system, refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit that can be walked into, and has a total chilled storage area of less than 3,000 square feet; however, the terms do not include products designed and marketed exclusively for medical, scientific, or research purposes.

* * * * *

■ 8. Amend § 431.303 by:
■ a. Revising paragraph (a);
■ b. Adding paragraph (b)(3);
■ c. Revising paragraphs (c), (d), and (e)(1).

The revisions and additions read as follows:

§ 431.303 Materials incorporated by reference.

(a) Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, DOE must publish a document in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at DOE, and at the National Archives and Records Administration (''NARA''). Contact DOE at the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–9127, *Buildings@ee.doe.gov, www.energy.gov/eere/buildings/building-technologies-office.* For information on the availability of this material at NARA, email: *fr.inspection@nara.gov,* or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html.* The material may be obtained from the sources in the following paragraphs of this section.

(b) * * *

(3) AHRI Standard 1250–2020 (''AHRI 1250–2020''), ''Standard for Performance Rating of Walk-in Coolers and Freezers,'' copyright 2020. IBR approved for appendix C1 to subpart R.

(c) *ASHRAE.* American Society of Heating, Refrigerating and Air-Conditioning Engineers, 180 Technology Parkway, Peachtree Corners, GA 30092; (404) 636–8400; *www.ashrae.org.*

(1) ANSI/ASHRAE Standard 16–2016, (''ANSI/ASHRAE 16''), ''Method of Testing for Rating Room Air Conditioners, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps for Cooling and Heating Capacity,'' approved October 31, 2016, IBR approved for appendix C1 to subpart R.

(2) ANSI/ASHRAE Standard 23.1–2010, (''ASHRAE 23.1–2010''), ''Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant,'' ANSI approved January 28, 2010, IBR approved for appendix C to subpart R of part 431.

(3) ANSI/ASHRAE Standard 37–2009, (''ANSI/ASHRAE 37''), ''Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment,'' ASHRAE approved June 24, 2009, IBR approved for appendices C and C1 to subpart R.

(d) *ASTM.* ASTM, International, 100 Barr Harbor Drive, West Conshohocken, PA 19428–2959; (610) 832–9500; *www.astm.org.*

(1) ASTM C518–17, (''ASTM C518–17''), ''Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus,'' approved May 1, 2017, IBR approved for appendix B to subpart R.

(2) ASTM C1199–14, (''ASTM C1199–14''), ''Standard Test Method for Measuring the Steady-State Thermal Transmittance of Fenestration Systems Using Hot Box Methods,'' approved February 1, 2014, IBR approved for appendix A to subpart R.

(e) * * *

(1) NFRC 102–2020 [E0A0], (''NFRC 102–2020''), ''Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems,'' IBR approved for appendix A to subpart R.

* * * * *

■ 9. Amend § 431.304 by revising paragraph (b) to read as follows:

§ 431.304 Uniform test method for the measurement of energy consumption of walk-in coolers and walk-in freezers.

* * * * *

(b) *Testing and Calculations.* Determine the energy efficiency and/or energy consumption of the specified walk-in cooler and walk-in freezer components by conducting the appropriate test procedure as follows:

(1) *Display panels.* Determine the energy use of walk-in cooler and walk-in freezer display panels by conducting the test procedure set forth in appendix A to this subpart.

(2) *Display doors and non-display doors.* Determine the energy use of walk-in cooler and walk-in freezer display doors and non-display doors by conducting the test procedure set forth in appendix A to this subpart.

(3) *Non-display panels and non-display doors.* Determine the R-value of insulation of walk-in cooler and walk-in freezer non-display panels and non-display doors by conducting the test procedure set forth in appendix B to this subpart.

(4) *Refrigeration systems.* Determine the Annual Walk-in Energy Factor (AWEF) and net capacity of walk-in cooler and walk-in freezer refrigeration systems by conducting the test procedures set forth in appendix C or C1 to this subpart, as applicable. Refer to the notes at the beginning of those appendices to determine the applicable appendix to use for testing.

(i) For unit coolers: Follow the general testing provisions in sections 3.1 and 3.2 of appendices C or C1 to this subpart, and the equipment-specific provisions in section 3.3 of appendix C or sections 4.5 through 4.8 of appendix C1.

(ii) For dedicated condensing units: Follow the general testing provisions in sections 3.1 and 3.2 of appendices C or C1 to this subpart, and the product-specific provisions in section 3.4 of appendix C or sections 4.5 through 4.8 of appendix C1.

(iii) For single-packaged dedicated systems: Follow the general testing provisions in sections 3.1 and 3.2 of appendices C or C1 to this subpart, and the product-specific provisions in section 3.3 of appendix C or sections 4.5 through 4.8 of appendix C1.

■ 10. Revise appendix A to subpart R of part 431 to read as follows:

Appendix A to Subpart R of Part 431—Uniform Test Method for the Measurement of Energy Consumption of the Components of Envelopes of Walk-in Coolers and Walk-in Freezers

Note: Prior to [*date 180 days after publication of final rule*], representations with respect to the energy use of envelope components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with the applicable provisions of 10 CFR part 431, subpart R, appendix A, revised as of January 1, 2022. Beginning [*date 180 days after publication of final rule*], representations with respect to energy use of envelope components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with this appendix.

Incorporation by Reference

DOE incorporated by reference in § 431.303 the entire standards for NFRC 102–2020, and ASTM C1199–14. However, certain enumerated provisions of these standards, as set forth in sections 0.1 and 0.2 of this appendix are inapplicable. To the extent that there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

0.1 NFRC 102–2020

0.1.1 Section 1 Scope, is inapplicable as specified in section 5.1.1.1 of this appendix,

0.1.2 Section 4 Significance and Use, is inapplicable as specified in section 5.1.1.2 of this appendix,

0.1.3 Section 7.3 Test Conditions, is inapplicable as specified in section 5.1.1.3 of this appendix,

0.1.4 Section 10 Report, is inapplicable as specified in section 5.1.1.4 of this appendix,

0.1.5 Section 11 Precision and Bias, is inapplicable as specified in section 5.1.1.5 of this appendix,

0.1.6 Annex A3 Standard Test Method for Determining the Thermal Transmittance of Tubular Daylighting Devices, is inapplicable as specified in section 5.1.1.6 of this appendix, and

0.1.7 Annex A5 Tables and Figures, is inapplicable as specified in section 5.1.1.7 of this appendix.

0.2 ASTM C1199–14

0.2.1 Section 1 Scope, is inapplicable as specified in section 5.1.2.1 of this appendix,

0.2.2 Section 4 Significance and Use is inapplicable as specified in section 5.1.2.2 of this appendix, 0.2.3 Section 7.3 Test Conditions, is inapplicable as specified in section 5.1.2.3 of this appendix,

0.2.4 Section 10 Report, is inapplicable as specified in section 5.1.2.4 of this appendix, and

0.2.5 Section 11 Precision and Bias, is inapplicable as specified in section 5.1.2.5 of this appendix.

1. *General.* The following sections of this appendix provide additional instructions for testing. In cases where there is a conflict, the language of this appendix takes highest precedence, followed by NFRC 102–2020, followed by ASTM C1199–14. Any subsequent amendment to a referenced document by the standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE. Material is incorporated as it exists on the date of the approval, and a notification of any change in the incorporation will be published in the **Federal Register**.

2. *Scope.*

This appendix covers the test requirements used to measure the energy consumption of the components that make up the envelope of a walk-in cooler or walk-in freezer.

3. *Definitions.*

The definitions contained in § 431.302 are applicable to this appendix.

4. *Additional Definitions.*

4.1 *Automatic door opener/closer* means a device or control system that ''automatically'' opens and closes doors without direct user contact, such as a motion sensor that senses when a forklift is approaching the entrance to a door and opens it, and then closes the door after the forklift has passed.

4.2 *Percent time off (PTO)* means the percent of time that an electrical device is assumed to be off.

4.3 *Rated power* means the input power of an electricity-consuming device as specified on the device's nameplate. If the device does not have a nameplate or such nameplate does not list the device's input power, then the rated power must be determined from the device's product data sheet, literature, or installation instructions that come with the device or are available online.

4.4 *Rating conditions* means, unless explicitly stated otherwise, all conditions shown in Table A.1 of this appendix.

TABLE A.1—TEMPERATURE CONDITIONS

Internal Temperatures (cooled space within the envelope)	
Cooler Dry Bulb Temperature	35 °F.
Freezer Dry Bulb Temperature	−10 °F.
External Temperatures (space external to the envelope)	
Freezer and Cooler Dry Bulb Temperatures.	75 °F.

5. *Test Methods and Measurements.*

5.1 U-factor Test of Doors and Display Panels.

Determine the U-factor of the entire door or display panel, including the frame, in accordance with the specified sections of NFRC 1022020 and ASTM C1199–14 at the temperature conditions listed in Table A.1 of this appendix; however, the following enumerated provisions of NFRC 102–2020 and ASTM C1199–14 are not applicable, as set forth in sections 5.1.1 and 5.1.2 of this appendix.

5.1.1 *Excepted sections of NFRC 102–2020.*

5.1.1.1 Section 1 Scope,

5.1.1.2 Section 4 Significance and Use,

5.1.1.3 Section 7.3 Test Conditions,

5.1.1.4 Section 10 Report,

5.1.1.5 Section 11 Precision and Bias,

5.1.1.6 Annex A3 Standard Test Method for Determining the Thermal Transmittance of Tubular Daylighting Devices, and

5.1.1.7 Annex A5 Tables and Figures.

5.1.2 *Excepted sections of ASTM C1199–14.*

5.1.2.1 Section 1 Scope,

5.1.2.2 Section 4 Significance and Use,

5.1.2.3 Section 7.3 Test Conditions,

5.1.2.4 Section 10 Report, and

5.1.2.5 Section 11 Precision and Bias.

5.2 Required Test Measurements.

5.2.1 For display doors and display panels, thermal transmittance, U_{dd} or U_{dp}, respectively, shall be the standardized thermal transmittance, U_{ST}, determined per section 5.1.1 of this appendix.

5.2.2 For non-display doors, thermal transmittance, U_{nd}, shall be the standardized thermal transmittance, U_{ST}, determined per section 5.1 of this appendix.

5.2.3 Projected area of the test specimen, A_s, in ft², as referenced in ASTM C1199–14.

6. *Calculations.*

6.1 Display Panels.

6.1.1 Determine the U-factor of the display panel in accordance with section 5.1 of this appendix, in units of Btu/(h-ft²-°F).

6.1.2 Calculate the temperature differential, ΔT_{dp}, °F, for the display panel, as follows:

$$\Delta T_{dp} = \left|T_{DB,ext,dp} - T_{DB,int,dp}\right| \qquad \text{(A-1)}$$

Where:

$T_{DB,ext,dp}$ = dry-bulb air external temperature, °F, as prescribed in Table A.1 of this appendix; and

$T_{DB,int,dp}$ = dry-bulb air temperature internal to the cooler or freezer, °F, as prescribed in Table A.1 of this appendix.

6.1.3 Calculate the conduction load through the display panel, $Q_{cond\text{-}dp}$, Btu/h, as follows:

$$Q_{cond,dp} = A_s \times \Delta T_{dp} \times U_{dp} \qquad \text{(A-2)}$$

Where:

A_s = projected area of the test specimen (same as the test specimen aperture in the surround panel) or the area used to determine the U-factor in section 5.1 of this appendix, ft²;

ΔT_{dp} = temperature differential between refrigerated and adjacent zones, °F; and

U_{dp} = thermal transmittance, U-factor, of the display panel in accordance with section 5.1 of this appendix, Btu/(h-ft²-°F).

6.1.4 Calculate the total daily energy consumption, E_{dp}, kWh/day, as follows:

$$E_{dp} = \frac{Q_{cond,dp}}{EER} \times \frac{24\ h \times 1\ kW}{1\ day \times 1000\ W} \qquad \text{(A-3)}$$

Where:

$Q_{cond,dp}$ = the conduction load through the display panel, Btu/h; and

EER = Energy Efficiency Ratio of walk-in (cooler or freezer), Btu/W-h. For coolers, use EER = 12.4 Btu/W-h. For freezers, use EER = 6.3 Btu/W-h.

6.2 Display Doors.

6.2.1 Conduction Through Display Doors.

6.2.1.1 Determine the U-factor of the display door in accordance with section 5.1 of this appendix, in units of Btu/(h-ft²-°F).

6.2.1.2 Calculate the temperature differential, ΔT_{dd}, °F, for the display door as follows:

$$\Delta T_{dd} = \left| T_{DB,ext,dd} - T_{DB,int,dd} \right| \quad \text{(A-4)}$$

Where:

$T_{DB,ext,dd}$ = dry-bulb air temperature external to the display door, °F, as prescribed in Table A.1 of this appendix; and

$T_{DB,int,dd}$ = dry-bulb air temperature internal to the display door, °F, as prescribed in Table A.1 of this appendix.

6.2.1.3 Calculate the conduction load through the display doors, $Q_{cond,dd}$, Btu/h, as follows:

$$Q_{cond,dd} = A_s \times \Delta T_{dd} \times U_{dd} \quad \text{(A-5)}$$

Where:

A_s = projected area of the test specimen (same as the test specimen aperture in the surround panel) or the area used to determine the U-factor in section 5.1 of this appendix, ft²;

ΔT_{dd} = temperature differential between refrigerated and adjacent zones, °F; and

U_{dd} = thermal transmittance, U-factor of the door, in accordance with section 5.1 of this appendix, Btu/(h-ft²-°F).

6.2.1.4 Calculate the total daily energy consumption due to conduction thermal load, $E_{dd,thermal}$, kWh/day, as follows:

$$E_{dd,thermal} = \frac{Q_{cond,dd}}{EER} \times \frac{24\ h \times 1\ kW}{1\ day \times 1000\ W} \quad \text{(A-6)}$$

Where:

$Q_{cond,dd}$ = the conduction load through the display door, Btu/h; and

EER = EER of walk-in (cooler or freezer), Btu/W-h. For coolers, use EER = 12.4 Btu/(W-h). For freezers, use EER = 6.3 Btu/(W-h).

6.2.2 Direct Energy Consumption of Electrical Component(s) of Display Doors.

Electrical components associated with display doors could include but are not limited to: Heater wire (for anti-sweat or anti-freeze application); lights; door motors; control system units; and sensors.

6.2.2.1 Select the required value for percent time off (PTO) for each type of electricity-consuming device per Table A.2 of this appendix, PTO_t (%).

TABLE A.2—PERCENT TIME OFF VALUES

Device	Temperature condition	Controls	Percent time off value (%)
Lights	All	Without	25
		With	50
Anti-sweat heaters	All	Without	0
	Coolers	With	75
	Freezers	With	50
Door motors	All		97
All other electricity-consuming devices	All	Without	0
		With	25

6.2.2.2 Calculate the power usage for each type of electricity-consuming device, $P_{dd,comp,u,t}$, kWh/day, as follows:

$$P_{dd,comp,u,t} = P_{rated,u,t} \times (1 - PTO_{u,t}) \times n_{u,t} \times \frac{24\ h}{day} \quad \text{(A-7)}$$

Where:

u = the index for each of type of electricity-consuming device located on either (1) the interior facing side of the display door or within the inside portion of the display door, (2) the exterior facing side of the display door, or (3) any combination of (1) and (2). For purposes of this calculation, the interior index is represented by u = int and the exterior index is represented by u = ext. If the electrical component is both on the interior and exterior side of the display door then use u = int. For anti-sweat heaters sited anywhere in the display door, 75 percent of the total power is be attributed to u = int and 25 percent of the total power is attributed to u = ext;

t = index for each type of electricity-consuming device with identical rated power;

$P_{rated,u,t}$ = rated input power of each component, of type t, kW;

$PTO_{u,t}$ = percent time off, for device of type t, %; and

$n_{u,t}$ = number of devices at the rated input power of type t, unitless.

6.2.2.3 Calculate the total electrical energy consumption for interior and exterior power, $P_{dd,tot,int}$ (kWh/day) and $P_{dd,tot,ext}$ (kWh/day), respectively, as follows:

$$P_{dd,tot,int} = \sum_1^t P_{dd,comp,int,t} \quad \text{(A-8)}$$

$$P_{dd,tot,ext} = \sum_1^t P_{dd,comp,ext,t} \quad \text{(A-9)}$$

Where:

t = index for each type of electricity-consuming device with identical rated input power;

$P_{dd,comp,int,t}$ = the energy usage for an electricity-consuming device sited on the interior facing side of or in the display door, of type t, kWh/day; and

$P_{dd,comp,ext,t}$ = the energy usage for an electricity-consuming device sited on the external facing side of the display door, of type t, kWh/day.

6.2.2.4 Calculate the total electrical energy consumption, $P_{dd,tot}$, (kWh/day), as follows:

$$P_{dd,tot} = P_{dd,tot,int} + P_{dd,tot,ext} \quad \text{(A-10)}$$

Where:

$P_{dd,tot,int}$ = the total interior electrical energy usage for the display door, kWh/day; and

$P_{dd,tot,ext}$ = the total exterior electrical energy usage for the display door, kWh/day.

6.2.3 Total Indirect Electricity Consumption Due to Electrical Devices.

Calculate the additional refrigeration energy consumption due to thermal output from electrical components sited inside the display door, $C_{dd,load}$, kWh/day, as follows:

$$C_{dd,load} = P_{dd,tot,int} \times \frac{3.412\ Btu/(Wh)}{EER} \quad \text{(A-11)}$$

Where:

$P_{dd,tot,int}$ = The total internal electrical energy consumption due for the display door, kWh/day; and

EER = EER of walk-in cooler or walk-in freezer, Btu/W-h. For coolers, use EER = 12.4 Btu/(W-h). For freezers, use EER = 6.3 Btu/(W-h).

6.2.4 Total Display Door Energy Consumption.

Calculate the total energy, $E_{dd,tot}$, kWh/day,

$$E_{dd,tot} = E_{dd,thermal} + P_{dd,tot} + C_{dd,load} \quad \text{(A-12)}$$

Where:

$E_{dd,thermal}$ = the total daily energy consumption due to thermal load for the display door, kWh/day;

$P_{dd,tot}$ = the total electrical load, kWh/day; and

$C_{dd,load}$ = additional refrigeration load due to thermal output from electrical components contained within the display door, kWh/day.

6.3 Non-Display Doors.

6.3.1 Conduction Through Non-Display Doors.

6.3.1.1 Determine the U-factor of the non-display door in accordance with section 5.1 of this appendix, in units of Btu/(h-ft²-°F).

6.3.1.2 Calculate the temperature differential of the non-display door, ΔT_{nd}, °F, as follows:

$$\Delta T_{nd} = \left| T_{DB,ext,nd} - T_{DB,int,nd} \right| \quad \text{(A-13)}$$

Where:

$T_{DB,ext,nd}$ = dry-bulb air external temperature, °F, as prescribed by Table A.1 of this appendix; and

$T_{DB,int,nd}$ = dry-bulb air internal temperature, °F, as prescribed by Table A.1 of this appendix. If the component spans both cooler and freezer spaces, the freezer temperature must be used.

6.3.1.3 Calculate the conduction load through the non-display door: $Q_{cond,nd}$, Btu/h,

$$Q_{cond,nd} = A_s \times \Delta T_{nd} \times U_{nd} \quad \text{(A-14)}$$

Where:

A_s = projected area of the test specimen (same as the test specimen aperture in the surround panel) or the area used to determine the U-factor in section 5.1 of this appendix, ft²;

ΔT_{nd} = temperature differential across the non-display door, °F; and

U_{nd} = thermal transmittance, U-factor of the door, in accordance with section 5.1 of this appendix, Btu/(h-ft²-°F).

6.3.1.4 Calculate the total daily energy consumption due to thermal load, $E_{nd,thermal}$, kWh/day, as follows:

$$E_{nd,thermal} = \frac{Q_{cond,nd}}{EER} \times \frac{24\ h \times 1\ kW}{1\ day \times 1000\ W} \quad \text{(A-15)}$$

Where:

$Q_{cond,nd}$ = the conduction load through the non-display door, Btu/h; and

EER = EER of walk-in (cooler or freezer), Btu/W-h. For coolers, use EER = 12.4 Btu/(W-h). For freezers, use EER = 6.3 Btu/(W-h).

6.3.2 Direct Energy Consumption of Electrical Components of Non-Display Doors.

Electrical components associated with non-display doors comprise could include, but are not limited to: Heater wire (for anti-sweat or anti-freeze application), lights, door motors, control system units, and sensors.

6.3.2.1 Select the required value for percent time off for each type of electricity-consuming device per Table A.2 of this appendix, PTO_t (%).

6.3.2.2 Calculate the power usage for each type of electricity-consuming device, $P_{nd,comp,u,t}$, kWh/day, as follows:

$$P_{nd,comp,u,t} = P_{rated,u,t} \times (1 - PTO_{u,t}) \times n_{u,t} \times \frac{24\,h}{day} \quad \text{(A-16)}$$

Where:

u = the index for each of type of electricity-consuming device located on either (1) the interior facing side of the non-display door or within the inside portion of the non-display door, (2) the exterior facing side of the non-display door, or (3) any combination of (1) and (2). For purposes of this calculation, the interior index is represented by u = int and the exterior index is represented by u = ext. If the electrical component is both on the interior and exterior side of the non-display door then use u = int. For anti-sweat heaters sited anywhere in the non-display door, 75 percent of the total power is be attributed to u = int and 25 percent of the total power is attributed to u = ext;

t = index for each type of electricity-consuming device with identical rated input power;

$P_{rated,u,t}$ = rated input power of each component, of type t, kW;

$PTO_{u,t}$ = percent time off, for device of type t, %; and

$n_{u,t}$ = number of devices at the rated input power of type t, unitless.

6.3.2.3 Calculate the total electrical energy consumption for interior and exterior power, $P_{nd,tot,int}$, kWh/day, and $P_{nd,tot,ext}$, kWh/day, respectively, as follows:

$$P_{nd,tot,int} = \sum_1^t P_{nd,comp,int,t} \quad \text{(A-17)}$$

$$P_{nd,tot,ext} = \sum_1^t P_{nd,comp,ext,t} \quad \text{(A-18)}$$

Where:

t = index for each type of electricity-consuming device with identical rated input power;

$P_{nd,comp,int,t}$ = the energy usage for an electricity-consuming device sited on the internal facing side or internal to the non-display door, of type t, kWh/day; and

$P_{nd,comp,ext,t}$ = the energy usage for an electricity-consuming device sited on the external facing side of the non-display door, of type t, kWh/day. For anti-sweat heaters,

6.3.2.4 Calculate the total electrical energy consumption, $P_{nd,tot}$, kWh/day, as follows:

$$P_{nd,tot} = P_{nd,tot,int} + P_{nd,tot,ext} \quad \text{(A-19)}$$

Where:

$P_{nd,tot,int}$ = the total interior electrical energy usage for the non-display door, of type t, kWh/day; and

$P_{nd,tot,ext}$ = the total exterior electrical energy usage for the non-display door, of type t, kWh/day.

6.3.3 Total Indirect Electricity Consumption Due to Electrical Devices.

Calculate the additional refrigeration energy consumption due to thermal output from electrical components associated with the non-display door, $C_{nd,load}$, kWh/day, as follows:

$$C_{nd,load} = P_{nd,tot,int} \times \frac{3.412\,Btu/(Wh)}{EER} \quad \text{(A-20)}$$

Where:

$P_{nd,tot,int}$ = the total interior electrical energy consumption for the non-display door, kWh/day; and

EER = EER of walk-in cooler or freezer, Btu/W-h. For coolers, use EER = 12.4 Btu/(W-h). For freezers, use EER = 6.3 Btu/(W-h).

6.3.4 Total Non-Display Door Energy Consumption.

Calculate the total energy, $E_{nd,tot}$, kWh/day, as follows:

$$E_{nd,tot} = E_{nd,thermal} + P_{nd,tot} + C_{nd,load} \quad \text{(A-12)}$$

Where:

$E_{nd,thermal}$ = the total daily energy consumption due to thermal load for the non-display door, kWh/day;

$P_{nd,tot}$ = the total electrical energy consumption, kWh/day; and

$C_{nd,load}$ = additional refrigeration load due to thermal output from electrical components contained on the inside face of the non-display door, kWh/day.

■ 11. Revise appendix B to subpart R of part 431 to read as follows:

Appendix B to Subpart R of Part 431—Uniform Test Method for the Measurement of R-Value of Insulation for Envelope Components of Walk-In Coolers and Walk-In Freezers

Note: Prior to [*date 180 days after publication of final rule*], representations with respect to the R-value for insulation of envelope components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with the applicable provisions of 10 CFR part 431, subpart R, appendix B, revised as of January 1, 2022. Beginning [*date 180 days after publication of final rule*], representations with respect to R-value for insulation of envelope components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with this appendix.

0. *Incorporation by Reference.*

DOE incorporated by reference in § 431.303 the entire standard for ASTM C518–17. However, certain enumerated provisions of ASTM C518–17, as set forth in section 0.1 of this appendix, are inapplicable. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

0.1 ASTM C518–17

0.1.1 Section 1 Scope, is inapplicable as specified in section 5.3.1.1 of this appendix,

0.1.2 Section 4 Significance and Use, is inapplicable as specified in section 5.3.1.2 of this appendix,

0.1.3 Section 7.3 Specimen Conditioning, is inapplicable as specified in section 5.3.1.3 of this appendix,

0.1.4 Section 9 Report, is inapplicable as specified in section 5.3.1.4 of this appendix,

0.1.5 Section 10 Precision and Bias, is inapplicable as specified in section 5.3.1.5 of this appendix,

0.1.6 Section 11 Keywords, is inapplicable as specified in section 5.3.1.6 of this appendix,

0.1.7 Annex A2 Equipment Error Analysis, is inapplicable as specified in section 5.3.1.7 of this appendix,

0.1.8 Appendix X1 is inapplicable as specified in section 5.3.1.8 of this appendix,

0.1.9 Appendix X2 Response of Heat Flux Transducers, is inapplicable as specified in section 5.3.1.9 of this appendix, and

0.1.10 Appendix X3 Proven Performance of a Heat Flow Apparatus, is inapplicable as specified in section 5.3.1.10 of this appendix.

1. *General.*

The following sections of this appendix provide additional instructions for testing. In cases where there is a conflict, the language of this appendix takes highest precedence, followed by ASTM C518–17. Any subsequent amendment to a referenced document by the standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE. Material is incorporated as it exists on the date of the approval, and a notification of any change in the incorporation will be published in the **Federal Register**.

2. *Scope.*

This appendix covers the test requirements used to measure the R-value of non-display panels and non-display doors of a walk-in cooler or walk-in freezer.

3. *Definitions.*

The definitions contained in § 431.302 apply to this appendix.

4. *Additional Definitions.*

4.1 *Edge region* means a region of the envelope component that is wide enough to encompass any framing members. If the envelope component contains framing members (*e.g.,* a wood frame) then the width of the edge region must be as wide as any framing member plus an additional 2 in. ±0.25 in.

5. *Test Methods, Measurements, and Calculations.*

5.1 *General.* Foam shall be tested after it is produced in its final chemical form. For foam produced inside of an envelope component (''foam-in-place''), ''final chemical form'' means the foam is cured as intended and ready for use as a finished envelope component. For foam produced as board stock (*e.g.,* polystyrene), ''final chemical form'' means after extrusion and ready for assembly into an envelope component or after assembly into an envelope component. Foam must not include any structural members or non-foam materials during testing in accordance with ASTM C518–17. When preparing the specimen for test, a high-speed bandsaw or a meat slicer are two types of recommended cutting tools. Hot wire cutters or other heated tools shall not be used for cutting foam test specimens.

5.2 *Specimen Preparation.*

5.2.1 *Determining the thickness around the perimeter of the envelope component, t_p.* The full thickness of an envelope component around the perimeter, which may include facers on one or both sides, shall be determined as follows:

5.2.1.1 At least 8 thickness measurements shall be taken around the perimeter of the envelope component, at least 2 inches from the edge region, and avoiding any regions with hardware or fixtures.

5.2.1.2 The average of the thickness measurements taken around the perimeter of the envelope component shall be the thickness around the perimeter of the envelope component, t_p.

5.2.1.3 Measure and record the width, w_p, and height, h_p, of the envelope component. The surface area of the envelope component, A_p, shall be determined as follows:

$$A_p = w_p \times h_p \qquad \text{(B-1)}$$

Where:

w_p = width of the envelope component, in.; and

h_p = height of the envelope component, in.

5.2.2. *Removing the sample from the envelope component.*

5.2.2.1. Determine the center of the envelope component relative to its height and its width.

5.2.2.2. Cut a sample from the envelope component that is at least the length and width dimensions of the heat flow meter, and where the marked center of the sample is at least 3 inches from any cut edge.

5.2.2.3. If the center of the envelope component contains any non-foam components (excluding facers), additional samples may be cut adjacent to the previous cut that is at least the length and width dimensions of the heat flow meter and is greater than 12 inches from the edge region.

5.2.3. *Determining the thickness at the center of the envelope component, t_c.* The full thickness of an envelope component at the center, which may include facers on one or both sides, shall be determined as follows:

5.2.3.1. At least 2 thickness measurements shall be taken in each quadrant of the cut sample removed from the envelope component per section 5.2.2 of this appendix, for a total of at least 8 measurements.

5.2.3.2. The average of the thickness measurements of the cut sample removed from the envelope component shall be the overall thickness of the cut sample, t_c.

5.2.3.3. Measure and record the width and height of the cut sample removed from the envelope component. The surface area of the cut sample removed from the envelope component, A_c, shall be determined as follows:

$$A_c = w_c \times h_c \qquad \text{(B-2)}$$

Where:

w_c = width of the cut sample removed from the envelope component, in.; and

h_c = height of the cut sample removed from the envelope component, in.

5.2.4. *Determining the total thickness of the foam within the envelope component, t_{foam}.* The average total thickness of the foam sample, without facers, shall be determined as follows:

5.2.4.1. Remove the facers on the envelope component sample, while minimally disturbing the foam.

5.2.4.2. Measure the thickness of each facer in 4 locations for a total of 4 measurements if 1 facer is removed, and a total of 8 measurements if 2 facers are removed. The average of all facer measurements shall be the thickness of the facers, t_{facers}, in.

5.2.4.3. The average total thickness of the foam, t_{foam}, in., shall be determined as follows:

$$t_{foam} = \frac{t_c A_c + t_p (A_p - A_c)}{A_p} - t_{facers} \qquad \text{(B-3)}$$

Where:

t_c = the average thickness of the center of the envelope component, in., as determined per sections 5.2.3.1 and 5.2.3.2 of this appendix;

A_c = the surface area of the center of the envelope component, in^2., as determined per section 5.2.3.3 of this appendix;

t_p = the average thickness of the perimeter of the envelope component, in., as determined per sections 5.2.1.1 and 5.2.1.2 of this appendix;

A_p = the average thickness of the center of the envelope component, in^2, as determined per section 5.2.1.3 of this appendix;

t_{facers} = the average thickness of the facers of the envelope component, in., as determined per section 5.2.4.2 of this appendix.

5.2.5 *Cutting, measuring, and determining parallelism and flatness of a 1-inch-thick specimen for test from the center of the cut envelope component sample.*

5.2.5.1 Cut a 1 ±0.1-inch-thick specimen from the center of the cut envelope sample. The 1-inch-thick test specimen shall be cut from the point that is equidistant from both edges of the sample (*i.e.,* shall be cut from the center point that would be directly between the interior and exterior space of the walk-in).

5.2.5.2 Document through measurement or photographs with measurement indicators that the specimen was taken from the center of the sample.

5.2.5.3 After the 1-inch specimen has been cut, and prior to testing, place the specimen on a flat surface and allow gravity to determine the specimen's position on the surface. This will be side 1.

5.2.5.4 To determine the flatness of side 1, take at least nine height measurements at equidistant positions on the specimen (*i.e.,* the specimen would be divided into 9 regions and height measurements taken at the center of each of these nine regions). Contact with the measurement indicator shall not indent the foam surface. From the height measurements taken, determine the least squares plane for side 1. For each measurement location, calculate the theoretical height from the least squares plane for side 1. Then, calculate the difference between the measured height and the theoretical least squares plane height at each location. The maximum difference minus the minimum difference out of the nine measurement locations is the flatness of side 1. For side 1 of the specimen to be considered flat, this shall be less than or equal to 0.03 inches.

5.2.5.5 To determine the flatness of side 2, turn the specimen over and allow gravity to determine the specimen's position on the surface. Repeat section 5.2.5.4 to determine the flatness of side 2.

5.2.5.6 To determine the parallelism of the specimen for side 1, calculate the theoretical height of the least squares plane at the furthest corners (*i.e.,* at points (0,0), (0,12), (12,0), and (12,12)) of the 12-inch by 12-inch test specimen. The difference between the maximum theoretical height and the minimum theoretical height shall be less than or equal to 0.03 inches for each side in order for side 1 to be considered parallel.

5.2.5.7 To determine the parallelism of the specimen for side 2, repeat section

5.2.5.8 The average thickness of the test specimen, *L,* shall be 1 ±0.1-inches determined using a minimum of 18 thickness measurements (*i.e.,* a minimum of 9 measurements on side 1 of the specimen and a minimum of 9 on side 2 of the specimen). This average thickness shall be used to determine the thermal conductivity, or K-factor.

5.3 *K-factor Test.* Determine the thermal conductivity, or K-factor, of the 1-inch-thick specimen in accordance with the specified sections of ASTM C518–17; however, the following enumerated provisions of ASTM C518–17 are not applicable, as set forth in section 5.3.1 of this appendix. Testing must be completed within 24 hours of the specimen being cut for testing per section 5.2.5 of this appendix.

5.3.1 *Excepted sections of ASTM C518–17.*

5.3.1.1 Section 1 Scope,

5.3.1.2 Section 4 Significance and Use,

5.3.1.3 Section 7.3 Specimen Conditioning,

5.3.1.4 Section 9 Report,

5.3.1.5 Section 10 Precision and Bias,

5.3.1.6 Section 11 Keywords,

5.3.1.7 Annex A2 Equipment Error Analysis,

5.3.1.8 Appendix X1,

5.3.1.9 Appendix X2 Response of Heat Flux Transducers, and

5.3.1.10 Appendix X3 Proven Performance of a Heat Flow Apparatus.

5.3.2 *Test Conditions.*

5.3.2.1 For freezer envelope components, the K-factor of the specimen shall be determined at an average specimen temperature of 20 ±1 degrees Fahrenheit.

5.3.2.2 For cooler envelope components, the K-factor of the specimen shall be determined at an average specimen temperature of 55 ±1 degrees Fahrenheit.

5.4 *R-value Calculation.*

5.4.1 For envelope components consisting of one homogeneous layer of insulation, calculate the R-value, h-ft^2-°F/Btu, as follows:

$$R = \frac{t_{foam}}{\lambda} \qquad \text{(B-4)}$$

Where:

t_{foam} = the total thickness of the foam, in., as determined in section 5.2.4 of this appendix; and

λ = K-factor, Btu-in/(h-ft^2-°F), as determined in section 5.3 of this appendix.

5.4.2 For envelope components consisting of two or more layers of dissimilar insulating materials (excluding facers or protective skins), determine the K-factor of each material as described in sections 5.1 through 5.3 of this appendix. For an envelope component with N layers of insulating material, the overall R-value shall be calculated as follows:

$$R = \sum_{i=1}^{N} \frac{t_i}{\lambda_i} \qquad \text{(B-5)}$$

Where:

t_i is the thickness of the ith material that appears in the envelope component, inches, as determined in section 5.2.4 of this appendix;

λ_i is the k factor of the ith material, Btu-in/(h-ft^2-°F), as determined in section 5.3 of this appendix; and

N is the total number of material layers that appears in the envelope component.

5.4.3 K-factor test results from a test sample 1 ±0.1-inches in thickness may be used to determine the R-value of envelope components with various foam thicknesses as long as the foam throughout the panel depth is of the same final chemical form and the test was completed at the same test conditions that the other envelope components would be used at. For example, a K-factor test result conducted at cooler conditions cannot be used to determine R-value of a freezer envelope component.

■ 12. Amend appendix C to subpart R of part 431 by:

■ a. Adding a note to the beginning of the appendix;

■ b. Revising sections 2.0 and 3.1.1;

■ c. Adding sections 3.1.6 and 3.1.7;

■ d. Revising sections 3.2.1 and 3.2.3;

■ e. Adding sections 3.2.6, 3.2.7, 3.2.7.1, 3.2.7.2, 3.2.7.3, and 3.2.8;

■ f. Revising sections 3.3.1 and 3.3.3;

■ g. Adding sections 3.3.3.1, 3.3.3.2, 3.3.3.3, 3.3.3.3.1, and 3.3.3.3.2;

■ h. Revising sections 3.3.7, 3.3.7.1, and 3.3.7.2;

■ i. Adding sections 3.3.7.3, 3.3.7.3.1, and 3.3.7.3.2; and

■ j. Revising section 3.4.2.1.

The additions and revisions read as follows:

Appendix C to Subpart R of Part 431—Uniform Test Method for the Measurement of Net Capacity and AWEF of Walk-In Cooler and Walk-In Freezer Refrigeration Systems

Note: Prior to [*date 180 days after publication of final rule*], representations with respect to the energy use of refrigeration components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with the applicable provisions of this appendix as they appeared in 10 CFR part 431, subpart R, appendix C, revised as of January 1, 2022. Beginning [date 180 days after publication of final rule], representations with respect to energy use of refrigeration components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with this appendix.

For any amended standards for walk-in coolers and freezers published after January 1, 2022, manufacturers must use the results of testing under appendix C1 of this part to determine compliance. Representations related to energy consumption must be made in accordance with appendix C1 of this part when determining compliance with the relevant standard. Manufacturers may also use appendix C1 of this part to certify compliance with any amended standards prior to the applicable compliance date for those standards.

* * * * *

2.0 *Definitions.*

The definitions contained in § 431.302 and AHRI 1250–2009 (incorporated by reference; see § 431.303) apply to this appendix. When definitions contained in the standards DOE has incorporated by reference are in conflict or when they conflict with this section, the hierarchy of precedence shall be in the following order: § 431.302, AHRI 1250–2009, and then either AHRI 420–2008 (incorporated by reference; see § 431.303) for unit coolers or ASHRAE 23.1–2010 (incorporated by reference; see § 431.303) for dedicated condensing units.

The term ''unit cooler'' used in AHRI 1250–2009, AHRI 420–2008, and this subpart shall be considered to address both ''unit coolers'' and ''ducted fan-coil units,'' as appropriate.

3.0 * * *

3.1. * * *

3.1.1. In Table 1, Instrumentation Accuracy, refrigerant temperature measurements shall have an accuracy of +/−0.5 °F for unit cooler in/out. When testing high-temperature refrigeration systems, measurements used to determine temperature or water vapor content of the air (*i.e.* wet bulb or dew point) shall be accurate to within +/−0.25 °F; all other temperature measurements shall be accurate to within +/−1.0 °F.

* * * * *

3.1.6. *Test Operating Conditions for CO_2 Unit Coolers.*

For medium-temperature CO_2 unit coolers, conduct tests using the test conditions specified in Table 17 of this appendix. For low-temperature CO_2 unit coolers, conduct tests using the test conditions specified in Table 18 of this appendix.

TABLE 17—TEST OPERATING CONDITIONS FOR MEDIUM-TEMPERATURE CO_2 UNIT COOLERS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Suction dew point temp, °F	Liquid inlet bubble point temperature, °F	Liquid inlet subcooling, °F	Compressor capacity	Test objective
Off-Cycle Power	35	<50				Compressor On	Measure fan input power during compressor off cycle.
Refrigeration Capacity, Ambient Condition A.	35	<50	25	38	5	Compressor Off	Determine Net Refrigeration Capacity of Unit Cooler.

Notes:
1. Superheat shall be set as indicated in the installation instructions. If no superheat specification is given a default superheat value of 6.5 °F shall be used.

TABLE 18—TEST OPERATING CONDITIONS FOR LOW-TEMPERATURE CO_2 UNIT COOLERS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Suction dew point temp, °F	Liquid inlet bubble point temperature °F	Liquid inlet subcooling, °F	Compressor capacity	Test objective
Off-Cycle Power	−10	<50				Compressor Off	Measure fan input power during compressor off cycle.
Refrigeration Capacity, Ambient Condition A.	−10	<50	−20	38	5	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler.
Defrost	−10	<50				Compressor Off	Test according to Appendix C Section C11 of AHRI 1250–2009.

Notes:
1. Superheat shall be set as indicated in the installation instructions. If no superheat specification is given a default superheat value of 6.5 °F shall be used.

3.1.7. *Test Operating Conditions for High-Temperature Unit Coolers.*

For high temperature cooler unit coolers, conduct tests using the test conditions specified in Table 19 of this appendix.

TABLE 19—TEST OPERATING CONDITIONS FOR HIGH-TEMPERATURE UNIT COOLERS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, % [1]	Suction dew point temp, °F [2 3]	Liquid inlet bubble point temperature, °F	Liquid inlet subcooling, °F	Compressor capacity	Test objective
Off-Cycle	55	55		105	9	Compressor Off	Measure fan input power.
Refrigeration Capacity Suction A.	55	55	38	105	9	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler.

Notes:
1. The test condition tolerance (maximum permissible variation of the average value of the measurement from the specified test condition) for relative humidity is 3%.
2. Superheat shall be set as indicated in the installation instructions. If no superheat specification is given a default superheat value of 6.5 °F shall be used.
3. Suction Dew Point shall be measured at the Unit Cooler Exit.

3.2. * * *

3.2.1. *Refrigerant Temperature Measurements.*

In AHRI 1250–2009 appendix C, section C3.1.6, any refrigerant temperature measurements entering and leaving the unit cooler may use sheathed sensors immersed in the flowing refrigerant instead of thermometer wells. When testing a condensing unit alone, measure refrigerant liquid temperature leaving the condensing unit using thermometer wells as described in AHRI 1250–2009 appendix C, section C3.1.6 or sheathed sensors immersed in the flowing refrigerant. For all of these cases, if the refrigerant tube outer diameter is less than ½ inch, the refrigerant temperature may be measured using the average of two temperature measuring instruments with a minimum accuracy of ±0.5 °F placed on opposite sides of the refrigerant tube surface—resulting in a total of up to 8 temperature measurement devices used for the DX Dual Instrumentation method. In this case, the refrigerant tube shall be insulated with 1-inch thick insulation from a point 6 inches upstream of the measurement location to a point 6 inches downstream of the measurement location. Also, to comply with this requirement, the unit cooler entering measurement location may be moved to a location 6 inches upstream of the expansion device and, when testing a condensing unit alone, the entering and leaving measurement locations may be moved to locations 6 inches from the respective service valves.

* * * * *

3.2.3. *Subcooling at Refrigerant Mass Flow Meter.*

In appendix C, Section C3.4.5 of AHRI 1250–2009 (incorporated by reference; see § 431.303), and in Section 7.1.2 of ASHRAE 23.1–2010 (incorporated by reference; see § 431.303) when verifying sub-cooling at the mass flow meters, only the sight glass and a temperature sensor located on the tube surface under the insulation are required. Subcooling shall be verified to be within the 3 °F requirement downstream of flow meters located in the same chamber as a condensing unit under test and upstream of flow meters located in the same chamber as a unit cooler under test, rather than always downstream as indicated in AHRI 1250–2009, Section C3.4.5 or always upstream as indicated in Section 7.1.2 of ASHRAE 23.1–2010. If the subcooling is less than 3 °F, cool the line between the condensing unit outlet and this location to achieve the required subcooling. When providing such cooling while testing a matched pair, also measure the refrigerant temperature upstream of the location at which the line is being cooled, and increase the temperature used to calculate unit cooler entering enthalpy by the difference between the upstream and downstream temperatures.

* * * * *

3.2.6. *Installation Instructions.*

Manufacturer installation instructions or installation instructions described in this section refer to the instructions that come packaged with or appear on the labels applied to the unit. This does not include online manuals or materials.

Installation Instruction Hierarchy: If a given installation instruction provided on the label(s) applied to the unit conflicts with the installation instructions that are shipped with the unit, the label takes precedence. For testing of matched pairs, the installation instructions for the dedicated condensing unit shall take precedence. Setup shall be in accordance with the field installation instructions (laboratory installation instructions shall not be used). Achieving test conditions shall always take precedence over installation instructions.

3.2.7. *Refrigerant Charging and Adjustment of Superheat and Subcooling.*

All test samples shall be charged, and superheat and/or subcooling shall be set, at Refrigeration A test conditions unless otherwise specified in the installation instructions. If the installation instructions give a specified range for superheat, sub-cooling, or refrigerant pressure, the average of the range shall be used as the refrigerant charging parameter target and the test condition tolerance shall be ±50 percent of the range. Perform charging of near-azeotropic and zeotropic refrigerants only with refrigerant in the liquid state. Once the correct refrigerant charge is determined, all tests shall run until completion without further modification.

3.2.7.1. When charging or adjusting superheat/subcooling, use all pertinent instructions contained in the installation instructions to achieve charging parameters within the tolerances. However, in the event of conflicting charging information between installation instructions, follow the installation instruction hierarchy listed in section 3.2.6. of this appendix. Conflicting information is defined as multiple conditions given for charge adjustment where all conditions specified cannot be met. In the event of conflicting information within the same set of charging instructions (*e.g.,* the installation instructions shipped with the dedicated condensing unit), follow the hierarchy in Table 1 of this section for priority. Unless the installation instructions specify a different charging tolerance, the tolerances identified in Table 1 of this section shall be used.

TABLE 1—TEST CONDITION TOLERANCES AND HIERARCHY FOR REFRIGERANT CHARGING AND SETTING OF REFRIGERANT CONDITIONS

Priority	Fixed orifice		Expansion valve	
	Parameter with installation instruction target	Tolerance	Parameter with installation instruction target	Tolerance
1	Super-heat	± 2.0 °F	Sub-cooling	10% of the Target Value; No less than ±0.5 °F, No more than ±2.0 °F.

TABLE 1—TEST CONDITION TOLERANCES AND HIERARCHY FOR REFRIGERANT CHARGING AND SETTING OF REFRIGERANT CONDITIONS—Continued

Priority	Fixed orifice		Expansion valve	
	Parameter with installation instruction target	Tolerance	Parameter with installation instruction target	Tolerance
2	High Side Pressure or Saturation Temperature.	±4.0 psi or ±1.0 °F	High Side Pressure or Saturation Temperature.	±4.0 psi or ±1.0 °F.
3	Low Side Pressure or Saturation Temperature.	±2.0 psi or ±0.8 °F	Super-heat	±2.0 °F.
4	Low Side Temperature	±2.0 °F	Low Side Pressure or Saturation Temperature.	±2.0 psi or ±0.8 °F.
5	High Side Temperature	±2.0 °F	Approach Temperature.	±1.0 °F.
6	Charge Weight	±2.0 oz	Charge Weight	0.5% or 1.0 oz, whichever is greater.

3.2.7.2. *Dedicated Condensing Unit.* If the Dedicated Condensing Unit includes a receiver and the subcooling target leaving the condensing unit provided in installation instructions cannot be met without fully filling the receiver, the subcooling target shall be ignored. Likewise, if the Dedicated Condensing unit does not include a receiver and the subcooling target leaving the condensing unit cannot be met without the unit cycling off on high pressure, the subcooling target can be ignored. Also, if no instructions for charging or for setting subcooling leaving the condensing unit are provided in the installation instructions, the refrigeration system shall be set up with a charge quantity and/or exit subcooling such that the unit operates during testing without shutdown (*e.g.,* on a high-pressure switch) and operation of the unit is otherwise consistent with the requirements of the test procedure of this appendix and the installation instructions.

3.2.7.3. *Unit Cooler.* Use the shipped expansion device for testing. Otherwise, use the expansion device specified in the installation instructions. If the installation instructions specify multiple options for the expansion device, any specified expansion device may be used. The supplied expansion device shall be adjusted until either the superheat target is met, or the device reaches the end of its adjustable range. In the event the device reaches the end of its adjustable range and the super heat target is not met, test with the adjustment at the end of its range providing the closest match to the superheat target, and the test condition tolerance for super heat target shall be ignored. The measured superheat is not subject to a test operating tolerance. However, if the evaporator exit condition is used to determine capacity using the DX dual-instrumentation method or the refrigerant enthalpy method, individual superheat value measurements may not be equal to or less than zero. If this occurs, or if the operating tolerances of measurements affected by expansion device fluctuation are exceeded, the expansion device shall be replaced, operated at an average superheat value higher than the target, or both, in order to avoid individual superheat value measurements less than zero and/or to meet the required operating tolerances.

3.2.8. *Chamber Conditioning using the Unit Under Test.*

In appendix C, Section C6.2 of AHRI 1250–2009, for applicable system configurations (matched pairs, single-packaged refrigeration systems, and standalone unit coolers), the unit under test may be used to aid in achieving the required test chamber conditions prior to beginning any steady state test. However, the unit under test must be inspected and confirmed to be free from frost before initiating steady state testing.

3.3. * * *

3.3.1. For unit coolers tested alone, use test procedures described in AHRI 1250–2009 for testing unit coolers for use in mix-match system ratings, except that for the test conditions in Tables 15 and 16 of this appendix, use the Suction A saturation condition test points only. Also for unit coolers tested alone, other than high-temperature unit coolers, use the calculations in section 7.9 to determine AWEF and net capacity described in AHRI 1250–2009 for unit coolers matched to parallel rack systems.

* * * * *

3.3.3. *Evaporator Fan Power.*

3.3.3.1. *Ducted Evaporator Air.*

For ducted fan-coil units with ducted evaporator air, or that can be installed with or without ducted evaporator air: Connect ductwork on both the inlet and outlet connections and determine external static pressure as described in ASHRAE 37–2009 (incorporated by reference; see § 431.303), Sections 6.4 and 6.5. Use pressure measurement instrumentation as described in ASHRAE 37–2009, Section 5.3.2. Test at the fan speed specified in manufacturer installation instructions—if there is more than one fan speed setting and the installation instructions do not specify which speed to use, test at the highest speed. Conduct tests with the external static pressure equal to 50 percent of the maximum external static pressure allowed by the manufacturer for system installation within a tolerance of −0.00/+0.05 in. wc. Set the external static pressure by symmetrically restricting the outlet of the test duct. Alternatively, if using the indoor air enthalpy method to measure capacity, set external static pressure by adjusting the fan of the airflow measurement apparatus. In case of conflict, these requirements for setting evaporator airflow take precedence over airflow values specified in manufacturer installation instructions or product literature.

3.3.3.2. *Unit Coolers or Single-Packaged Systems that are not High-Temperature Refrigeration Systems.*

Use appendix C, Section C10 of AHRI 1250–2009 for off-cycle evaporator fan testing, with the exception that evaporator fan controls using periodic stir cycles shall be adjusted so that the greater of a 50% duty cycle (rather than a 25% duty cycle) or the manufacturer default is used for measuring off-cycle fan energy. For adjustable-speed controls, the greater of 50% fan speed (rather than 25% fan speed) or the manufacturer's default fan speed shall be used for measuring off-cycle fan energy. Also, a two-speed or multi-speed fan control may be used as the qualifying evaporator fan control. For such a control, a fan speed no less than 50% of the speed used in the maximum capacity tests shall be used for measuring off-cycle fan energy.

3.3.3.3. *High-Temperature Refrigeration Systems.*

3.3.3.3.1. The evaporator fan power consumption shall be measured in accordance with the requirements in Section C3.5 of AHRI 1250–2009. This measurement shall be made with the fan operating at full speed, either measuring unit cooler or total system power input upon the completion of the steady state test when the compressor and the condenser fan of the walk-in system are turned off, or by submetered measurement of the evaporator fan power during the steady state test.

Section C3.5 of AHRI 1250–2009 is revised to read:

Evaporator Fan Power Measurement.

The following shall be measured and recorded during a fan power test.

$EF_{comp,on}$ Total electrical power input to fan motor(s) of Unit Cooler, W

FS Fan speed(s), rpm

N Number of motors

P_b Barometric pressure, in. Hg

T_{db} Dry-bulb temperature of air at inlet, °F

T_{wb} Wet-bulb temperature of air at inlet, °F
V Voltage of each phase

For a given motor winding configuration, the total power input shall be measured at the highest nameplate voltage. For three-phase power, voltage imbalance shall be no more than 2%.

3.3.3.3.2. Evaporator fan power for the off-cycle is equal to the on-cycle evaporator fan power with a run time of ten percent of the off-cycle time.

$EF_{comp,off} = 0.1 \times EF_{comp,on}$

* * * * *

3.3.7. *Calculations for Unit Coolers Tested Alone.*

3.3.7.1. *Unit Coolers that are not High-Temperature Unit Coolers.*

Calculate the AWEF and net capacity using the calculations in AHRI 1250–2009, Section 7.9.

3.3.7.2. *High-Temperature Unit Coolers.*

Calculate AWEF on the basis that walk-in box load is equal to half of the system net capacity, without variation according to high and low load periods, and with EER set according to tested evaporator capacity, as follows:

The net capacity, $\dot{q}_{mix,evap}$, is determined from the test data for the unit cooler at the 38 °F suction dewpoint.

$$\dot{BL} = 0.5 \times \dot{q}_{mix,evap}$$

$$\dot{E}_{mix,rack} = \frac{\left(\dot{q}_{mix,evap} + 3.412 \times \dot{EF}_{comp,on}\right)}{EER} + \dot{EF}_{comp,on}$$

Where:

$$EER = \begin{cases} 11 & if\ \dot{q}_{mix,evap} < 10{,}000\ Btu/h \\ 0.0007 \times \dot{q}_{mix,evap} + 4 & if\ 10{,}000 \le \dot{q}_{mix,evap} < 20{,}000\ Btu/h \\ 18 & if\ 20{,}000 \le \dot{q}_{mix,evap} < 36{,}000\ Btu/h \end{cases}$$

$$LF = \frac{\dot{BL} + 3.412 \times \dot{EF}_{comp,off}}{\dot{q}_{mix,evap} + 3.412 \times \dot{EF}_{comp,off}}$$

$$AWEF = \frac{\dot{BL}}{\dot{E}_{mix,rack} \times LF + \dot{EF}_{comp,off} \times (1 - LF)}$$

Where:
$\dot{B}$L is the non-equipment-related box load;
LF is the load factor; and
Other symbols are as defined in Section 8 of AHRI 1250–2009.

3.3.7.3. If the unit cooler has variable-speed evaporator fans that vary fan speed in response to load, then:

3.3.7.3.1. When testing to certify compliance with the energy conservation standards in § 431.306, fans shall operate at full speed during on-cycle operation. Do not conduct the calculations in AHRI 1250–2009, Section 7.9.3. Instead, use AHRI 1250–2009, Section 7.9.2 to determine the system's AWEF.

3.3.7.3.2. When calculating the benefit for the inclusion of variable-speed evaporator fans that modulate fan speed in response to load for the purpose of making representations of efficiency, use AHRI 1250–2009, Section 7.9.3 to determine the system A WEF.

3.4. * * *

3.4.2. * * *

3.4.2.1. For calculating enthalpy leaving the unit cooler to calculate gross capacity, (a) the saturated refrigerant temperature (dew point) at the unit cooler coil exit, T_{evap}, shall be 25 °F for medium-temperature systems (coolers) and −20 °F for low-temperature systems (freezers), and (b) the refrigerant temperature at the unit cooler exit shall be 35 °F for medium-temperature systems (coolers) and −14 °F for low-temperature systems (freezers). For calculating gross capacity, the measured enthalpy at the condensing unit exit shall be used as the enthalpy entering the unit cooler. The temperature measurement requirements of appendix C, Section C3.1.6 of AHRI 1250–2009 and modified by section 3.2.1 of this appendix shall apply only to the condensing unit exit rather than to the unit cooler inlet and outlet, and they shall be applied for two measurements when using the DX Dual Instrumentation test method.

* * * * *

■ 13. Add appendix C1 to subpart R of part 431 to read as follows:

Appendix C1 to Subpart R of Part 431—Uniform Test Method for the Measurement of Net Capacity and AWEF of Walk-In Cooler and Walk-In Freezer Refrigeration Systems

Note: Prior to [*date 180 days after publication of final rule*], representations with respect to the energy use of refrigeration components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with the applicable provisions for 10 CFR part 431, subpart R, appendix C, revised as of January 1, 2022. Beginning [*date 180 days after publication of final rule*], representations with respect to energy use of refrigeration components of walk-in coolers and walk-in freezers, including compliance certifications, must be based on testing conducted in accordance with appendix C of this subpart.

For any amended standards for walk-in coolers and walk-in freezers published after January 1, 2022, manufacturers must use the results of testing under this appendix to determine compliance. Representations related to energy consumption must be made in accordance with this appendix when determining compliance with the relevant standard. Manufacturers may also use this appendix to certify compliance with any amended standards prior to the applicable compliance date for those standards.

1. *Incorporation by Reference*

DOE incorporated by reference in § 431.303, the entire standards for AHRI 1250–2020, ANSI/ASHRAE 16, and ANSI/ASHRAE 37. However, certain enumerated provisions of these standards, as set forth in sections 1.1, 1.2, and 1.3 of this appendix are inapplicable. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control. To the extent there is a conflict between the terms or provisions of AHRI 1250–2020, ANSI/ASHRAE 16, and ANSI/ASHRAE 37, the AHRI 1250–2020 provisions control.

1.1 AHRI 1250–2020

1.1.1 Section 1 Purpose, is inapplicable as specified in section 4.1.1 of this appendix.

1.1.2 Section 2 Scope, is inapplicable as specified in section 4.1.2 of this appendix.

1.1.3 Section 9 Minimum Data Requirements for Published Rating, is inapplicable as specified in section 4.1.3 of this appendix.

1.1.4 Section 10 Marking and Nameplate Data, is inapplicable as specified in section 4.1.4 of this appendix.

1.1.5 Section 11 Conformance Conditions, is inapplicable as specified in section 4.1.5 of this appendix.

1.2 ANSI/ASHRAE 16

1.2.1 Section 1 Purpose, is inapplicable as specified in section 4.2.1 of this appendix.

1.2.2 Section 2 Scope, is inapplicable as specified in section 4.2.2 of this appendix.

1.2.3 Section 4 Classifications, is inapplicable as specified in section 4.2.3 of this appendix.

1.2.4 Normative Appendices E–M, are inapplicable as specified in section 4.2.4 of this appendix.

1.2.5 Informative Appendices N–R, are inapplicable as specified in section 4.2.5 of this appendix.

1.3 ANSI/ASHRAE 37

1.3.1 Section 1 Purpose, is inapplicable as specified in section 4.3.1 of this appendix.

1.3.2 Section 2 Scope, is inapplicable as specified in section 4.3.2 of this appendix.

1.3.3 Section 4 Classifications, is inapplicable as specified in section 4.3.3 of this appendix.

1.3.4 Informative Appendix A Classifications of Unitary Air-conditioners and Heat Pumps, is inapplicable as specified in section 4.3.4 of this appendix.

2. *Scope.*

This appendix covers the test requirements used to determine the net capacity and the AWEF of the refrigeration system of a walk-in cooler or walk-in freezer.

3. *Definitions.*

3.1. Applicable Definitions.

The definitions contained in § 431.302, AHRI 1250–2020, ANSI/ASHRAE 37, and ANSI/ASHRAE 16 apply to this appendix. When definitions in standards incorporated by reference are in conflict or when they conflict with this section, the hierarchy of precedence shall be in the following order: § 431.302, AHRI 1250–2020, and then either ANSI/ASHRAE 37 or ANSI/ASHRAE 16.

The term ''unit cooler'' used in AHRI 1250–2020 and this subpart shall be considered to address both ''unit coolers'' and ''ducted fan-coil units,'' as appropriate.

3.2. Additional Definitions.

3.2.1. *Digital Compressor* means a compressor that uses mechanical means for disengaging active compression on a cyclic basis to provide a reduced average refrigerant flow rate in response to a control system input signal.

3.2.2. *Displacement Ratio,* applicable to staged positive displacement compressor systems, means the swept volume rate, *e.g.,* in cubic centimeters per second, of a given stage, divided by the swept volume rate at full capacity.

3.2.3. *Duty Cycle,* applicable to digital compressors, means the fraction of time that the compressor is engaged and actively compressing refrigerant.

3.2.4. *Maximum Speed,* applicable to variable-speed compressors, means the maximum speed at which the compressor will operate under the control of the dedicated condensing system control system for extended periods of time, *i.e.,* not including short-duration boost-mode operation.

3.2.5. *Minimum Speed,* applicable to variable-speed compressors, means the minimum compressor speed at which the compressor will operate under the control of the dedicated condensing system control system.

3.2.6. *Multiple-Capacity,* applicable for describing a refrigeration system, indicates that it has three or more stages (levels) of capacity.

3.2.7. *Speed Ratio,* applicable to variable-speed compressors, means the ratio of operating speed to the maximum speed.

4. *Test Methods, Measurements, and Calculations.*

Determine the Annual Walk-in Energy Factor (AWEF) and net capacity of walk-in cooler and walk-in freezer refrigeration systems by conducting the test procedure set forth in AHRI 1250–2020, with the modifications to that test procedure provided in this section. However, certain sections of AHRI 1250–2020, ANSI/ASHRAE 37, and ANSI/ASHRAE 16 are not applicable, as set forth in sections 4.1, 4.2, and 4.3 of this appendix. Round AWEF measurements to the nearest 0.05 Btu/Wh. Round net capacity measurements as indicated in Table 1 of this appendix.

TABLE 1—ROUNDING OF REFRIGERATION SYSTEM NET CAPACITY

Net capacity range, Btu/h	Rounding multiple, Btu/h
<20,000	100
≥20,000 and <38,000	200
≥38,000 and <65,000	500
≥65,000	1,000

The following sections of this appendix provide additional instructions for testing. In cases where there is a conflict, the language of this appendix takes highest precedence, followed by AHRI 1250–2020, then ANSI/ASHRAE 37 or ANSI/ASHRAE 16. Any subsequent amendment to a referenced document by the standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE. Material is incorporated as it exists on the date of the approval, and a notice of any change in the incorporation will be published in the **Federal Register**.

4.1 Excepted sections of AHRI 1250–2020.

(a) Section 1 Purpose,

(b) Section 2 Scope,

(c) Section 9 Minimum Data Requirements for Published Ratings,

(d) Section 10 Marking and Nameplate Data, and

(e) Section 11 Conformance Conditions.

4.2 Excepted sections of ANSI/ASHRAE 16.

(a) Section 1 Purpose,

(b) Section 2 Scope,

(c) Section 4 Classifications,

(d) Normative Appendices E–M,

(e) Informative Appendices N–R.

4.3 Excepted sections of ANSI/ASHRAE 37.

(a) Section 1 Purpose,

(b) Section 2 Scope,

(c) Section 4 Classifications,

(d) Informative Appendix A Classifications of Unitary Air-conditioners and Heat Pumps.

4.4. Instrumentation Accuracy and Test Tolerances.

Use measuring instruments as described in Section 4.1 of AHRI 1250–2020, with the following additional requirement.

4.4.1. Electrical Energy Input measured in Wh with a minimum accuracy of ±0.5% of reading (for Off-Cycle tests per footnote 5 of Table C3 in Section C3.6.2 of AHRI 1250–2020).

4.5. Test Operating Conditions.

Test conditions used to determine AWEF shall be as specified in Tables 4 through 17 of AHRI 1250–2020. Tables 7 and 11 of AHRI 1250–2020, labeled to apply to variable-speed outdoor matched-pair refrigeration systems, shall also be used for testing variable-capacity single-packaged outdoor refrigeration systems, and also for testing multiple-capacity matched-pair or single-packaged outdoor refrigeration systems. Test conditions used to determine AWEF for refrigeration systems not specifically identified in AHRI 1250–2020 are as enumerated in sections 4.5.1 through 4.5.6 of this appendix.

4.5.1 Test Operating Conditions for High-Temperature Refrigeration Systems.

For fixed-capacity high-temperature matched-pair or single-packaged refrigeration systems with indoor condensing units, conduct tests using the test conditions specified in Table 2 of this appendix. For fixed-capacity high-temperature matched-pair or single-packaged refrigeration systems with outdoor condensing units, conduct tests using the test conditions specified in Table 3 of this appendix. For high-temperature unit coolers tested alone, conduct tests using the test conditions specified in Table 4 of this appendix.

TABLE 2—TEST OPERATING CONDITIONS FOR FIXED-CAPACITY HIGH-TEMPERATURE INDOOR MATCHED PAIR OR SINGLE-PACKAGED REFRIGERATION SYSTEMS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, % [1]	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F	Compressor status	Test objective
Off-Cycle Power	55	55			Compressor Off	Measure total input wattage during compressor off cycle, $(\dot{E}_{cu,off} + \dot{E}F_{comp,off})$ [2].
Refrigeration Capacity A	55	55	90	75,[3] 65 [4]	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler, input power, and EER at Test Condition.

Notes:
[1] The test condition tolerance (maximum permissible variation of the average value of the measurement from the specified test condition) for relative humidity is 3%.
[2] Measure off-cycle power as described in Sections C3 and C4.2 of AHRI 1250–2020.
[3] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[4] Maximum allowable value for Single-Packaged Systems that do not use evaporative Dedicated Condensing Units, where all or part of the equipment is located in the outdoor room.

TABLE 3—TEST OPERATING CONDITIONS FOR FIXED-CAPACITY HIGH-TEMPERATURE OUTDOOR MATCHED-PAIR OR SINGLE-PACKAGED REFRIGERATION SYSTEMS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, % [1]	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F	Compressor status	Test objective
Refrigeration Capacity A	55	55	95	75,[3] 68 [4]	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler, input power, and EER at Test Condition.
Off-Cycle Power, Capacity A	55	55	95	75,[3] 68 [4]	Compressor Off	Measure total input wattage during compressor off cycle, $(\dot{E}_{cu,off} + \dot{E}F_{comp,off})$ [2].
Refrigeration Capacity B	55	55	59	54,[3] 46 [4]	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler and system input power at moderate condition.
Off-Cycle Power, Capacity B	55	55	59	54,[3] 46 [4]	Compressor Off	Measure total input wattage during compressor off cycle, $(\dot{E}_{cu,off} + \dot{E}F_{comp,off})$ [2].
Refrigeration Capacity C	55	55	35	34,[3] 29 [4]	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler and system input power at cold condition.
Off-Cycle Power, Capacity C	55	55	35	34,[3] 29 [4]	Compressor Off	Measure total input wattage during compressor off cycle, $(\dot{E}_{cu,off} + \dot{E}F_{comp,off})$ [2]

Notes:
[1] The test condition tolerance (maximum permissible variation of the average value of the measurement from the specified test condition) for relative humidity is 3%.
[2] Measure off-cycle power as described in Sections C3 and C4.2 of AHRI 1250–2020.
[3] Required only for evaporative condensing units (e.g., incorporates a slinger ring).
[4] Maximum allowable value for Single-Packaged Systems that do not use evaporative Dedicated Condensing Units, where all or part of the equipment is located in the outdoor room.

TABLE 4—TEST OPERATING CONDITIONS FOR HIGH-TEMPERATURE UNIT COOLERS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, % [1]	Suction dew point temp, °F [3 4]	Liquid inlet bubble point temperature, °F	Liquid inlet subcooling, °F	Compressor status	Test objective
Off-Cycle	55	55		105	9	Compressor Off	Measure unit cooler input wattage during compressor off cycle, $\dot{E}F_{comp,off}$ [2].
Refrigeration Capacity	55	55	38	105	9	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler, input power, and EER at Test Condition.

Notes:
[1] The test condition tolerance (maximum permissible variation of the average value of the measurement from the specified test condition) for relative humidity is 3%.
[2] Measure off-cycle power as described in Sections C3 and C4.2 of AHRI 1250–2020.
[3] Superheat shall be set as indicated in the installation instructions. If no superheat specification is given a default superheat value of 6.5 °F shall be used.
[4] Suction Dew Point shall be measured at the Unit Cooler Exit.

4.5.2 Test Operating Conditions for CO_2 Unit Coolers.

For medium-temperature CO_2 Unit Coolers, conduct tests using the test conditions specified in Table 5 of this appendix. For low-temperature CO_2 Unit Coolers, conduct tests using the test conditions specified in Table 6 of this appendix.

TABLE 5—TEST OPERATING CONDITIONS FOR MEDIUM-TEMPERATURE CO_2 UNIT COOLERS [1]

Test title	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Suction dew point temp,[3] °F	Liquid inlet bubble point temperature, °F	Liquid inlet subcooling, °F	Compressor operating mode	Test objective
Off-Cycle Power	35	<50				Compressor On	Measure unit cooler input wattage during compressor off cycle, $\dot{E}Fcomp,off$.[2]
Refrigeration Capacity, Ambient Condition A.	35	<50	25	38	5	Compressor Off	Determine Net Refrigeration Capacity of Unit Cooler, $\dot{q}mix,rack$.

Notes:
[1] Superheat shall be set as indicated in the installation instructions. If no superheat specification is given a default superheat value of 6.5 °F shall be used.
[2] Measure off-cycle power as described in Sections C3 and C4.2 of AHRI 1250–2020.
[3] Suction Dew Point shall be measured at the Unit Cooler Exit conditions.

TABLE 6—TEST OPERATING CONDITIONS FOR LOW-TEMPERATURE CO_2 UNIT COOLERS [1]

Test Title	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Suction dew point temp,[3] °F	Liquid inlet bubble point temperature, °F	Liquid inlet subcooling, °F	Compressor operating mode	Test objective
Off-Cycle Power	−10	<50				Compressor Off	Measure unit cooler input wattage during compressor off cycle, $\dot{E}Fcomp,off$.[2]
Refrigeration Capacity, Ambient Condition A.	−10	<50	−20	38	5	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler, $\dot{q}mix,rack$.
Defrost	−10	<50				Compressor Off	Test according to Appendix C Section C10 of AHRI 1250–2020, $\dot{D}F,\dot{Q}DF$.

Notes:
[1] Superheat shall be set as indicated in the installation instructions. If no superheat specification is given a default superheat value of 6.5 °F shall be used.
[2] Measure off-cycle power as described in Sections C3 and C4.2 of AHRI 1250–2020.
[3] Suction Dew Point shall be measured at the Unit Cooler Exit conditions.

4.5.3 Test Operating Conditions for Two-Capacity Condensing Units Tested Alone.

For two-capacity medium-temperature outdoor condensing units tested alone, conduct tests using the test conditions specified in Table 7 of this appendix. For two-capacity medium-temperature indoor condensing units tested alone, conduct tests using the test conditions specified in Table 8 of this appendix. For two-capacity low-temperature outdoor condensing units tested alone, conduct tests using the test conditions specified in Table 9 of this appendix. For two-capacity low-temperature indoor condensing units tested alone, conduct tests using the test conditions specified in Table 10 of this appendix.

TABLE 7—TEST OPERATING CONDITIONS FOR TWO-CAPACITY MEDIUM-TEMPERATURE OUTDOOR DEDICATED CONDENSING UNITS

Test description	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor status
Capacity, Condition A, Low Capacity.	Unit Cooler Low Fan:[2] 24.5 Unit Cooler High Fan:[2] 25.5	49 46	95	75	Low Capacity, k=1.
Capacity, Condition A, High Capacity.	23	41	95	75	High Capacity, k=2.
Off Cycle, Condition A			95	75	Off.
Capacity, Condition B, Low Capacity.	Unit Cooler Low Fan:[2] 24.5 Unit Cooler High Fan:[2] 25.5	47 45	59	54	Low Capacity, k=1.
Capacity, Condition B, High Capacity.	23		59	54	High Capacity, k=2.
Off Cycle, Condition B			59	54	Off.
Capacity, Condition C, Low Capacity.	Unit Cooler Low Fan:[2] 22.5 Unit Cooler High Fan:[2] 25.5	41 41	35	34	Low Capacity, k=1.
Capacity, Condition C, High Capacity.	23	41	35	34	High Capacity, k=2.
Off Cycle, Condition C			35	34	Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] When Staged compressor displacement ratio for low capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

TABLE 8—TEST OPERATING CONDITIONS FOR TWO-CAPACITY MEDIUM-TEMPERATURE INDOOR DEDICATED CONDENSING UNITS

Test description	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor status
Capacity, Condition A, Low Capacity.	Unit Cooler Low Fan: [2] 24.5 Unit Cooler High Fan: [2] 25.5	49 46	90	75	Low Capacity, k=1.
Capacity, Condition A, High Capacity.	23	41	90	75	High Capacity, k=2.
Off Cycle, Condition A			90	75	Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] When staged compressor displacement ratio for low capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

TABLE 9—TEST OPERATING CONDITIONS FOR TWO-CAPACITY LOW-TEMPERATURE OUTDOOR DEDICATED CONDENSING UNITS

Test title	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor operating mode
Capacity, Condition A, Low Capacity.	Unit Cooler Low Fan: [2] −20.5 Unit Cooler High Fan: [2] −19.5	21 13	95	75	Low Capacity, k=1.
Capacity, Condition A, High Capacity.	−22	5	95	75	High Capacity, k=2.
Off Cycle, Condition A			95	75	Compressor Off.
Capacity, Condition B, Low Capacity.	Unit Cooler Low Fan: [2] −20.5 Unit Cooler High Fan: [2] −19.5	19 13	59	54	Low Capacity, k=1.
Capacity, Condition B, High Capacity.	−22	5	59	54	High Capacity, k=2.
Off Cycle, Condition B			59	54	Compressor Off.
Capacity, Condition C, Low Capacity.	Unit Cooler Low Fan: [2] −20.5 Unit Cooler High Fan: [2] −19.5	17 12	35	34	Low Capacity, k=1.
Capacity, Condition C, High Capacity.	−22	5	35	34	Maximum Capacity, k=2.
Off Cycle, Condition C			35	34	Compressor Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] When staged compressor displacement ratio for low capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

TABLE 10—TEST OPERATING CONDITIONS FOR TWO-CAPACITY LOW-TEMPERATURE INDOOR DEDICATED CONDENSING UNITS

Test title	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor operating mode
Capacity, Condition A, Low Capacity.	Unit Cooler Low Fan: [2] −20.5 Unit Cooler High Fan: [2] −19.5	21 13	90	75	Low Capacity, k=1.
Capacity, Condition A, High Capacity.	−22	5	90	75	High Capacity, k=2.
Off Cycle, Condition A			90	75	Compressor Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] When staged compressor displacement ratio for low capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

4.5.4 Test Operating Conditions for Variable- or Multiple-Capacity Condensing Units Tested Alone.

For variable-capacity or multiple-capacity outdoor medium-temperature condensing units tested alone, conduct tests using the test conditions specified in Table 11 of this appendix. For variable-capacity or multiple-capacity indoor medium-temperature condensing units tested alone, conduct tests using the test conditions specified in Table 12 of this appendix. For variable-capacity or multiple-capacity outdoor low-temperature condensing units tested alone, conduct tests using the test conditions specified in Table 13 of this appendix. For variable-capacity or multiple-capacity indoor low-temperature condensing units tested alone, conduct tests using the test conditions specified in Table 14 of this appendix.

TABLE 11—TEST OPERATING CONDITIONS FOR VARIABLE- OR MULTIPLE-CAPACITY MEDIUM-TEMPERATURE OUTDOOR DEDICATED CONDENSING UNITS

Test description	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor status
Capacity, Condition A, Minimum Capacity.	26	56	95	75	Minimum Capacity, k=1.
Capacity, Condition A, Intermediate Capacity.	Unit Cooler Low Fan: [2] 22.5 Unit Cooler High Fan: [2] 25.5	44 46	95	75	Intermediate Capacity, k=i.
Capacity, Condition A, Maximum Capacity.	23	41	95	75	Maximum Capacity, k=2.
Off Cycle, Condition A			95	75	Off.
Capacity, Condition B, Minimum Capacity.	26	51	59	54	Minimum Capacity, k=1.
Capacity, Condition B, Intermediate Capacity.	Unit Cooler Low Fan: [2] 22.5 Unit Cooler High Fan: [2] 25.5	44 45	59	54	Intermediate Capacity, k=i.
Capacity, Condition B, Maximum Capacity.	23	41	59	54	Maximum Capacity, k=2.
Off Cycle, Condition B			59	54	Off.
Capacity, Condition C, Minimum Capacity.	26	41	35	34	Minimum Capacity, k=1.
Capacity, Condition C, Intermediate Capacity.	Unit Cooler Low Fan: [2] 22.5 Unit Cooler High Fan: [2] 25.5	41 41	35	34	Intermediate Capacity, k=i.
Capacity, Condition C, Maximum Capacity.	23	41	35	34	Maximum Capacity, k=2.
Off Cycle, Condition C			35	34	Off

Notes:

[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).

[2] When Digital Compressor duty cycle, variable-speed speed ratio, or staged compressor displacement ratio for intermediate capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

TABLE 12—TEST OPERATING CONDITIONS FOR VARIABLE- OR MULTIPLE-CAPACITY MEDIUM-TEMPERATURE INDOOR DEDICATED CONDENSING UNITS

Test description	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor status
Capacity, Condition A, Minimum Capacity.	26	56	90	75	Minimum Capacity, k=1.
Capacity, Condition A, Intermediate Capacity.	Unit Cooler Low Fan: [2] 22.5 Unit Cooler High Fan: [2] 25.5	44 46	90	75	Intermediate Capacity, k=i,
Capacity, Condition A, Maximum Capacity.	23	41	90	75	Maximum Capacity, k=2.
Off Cycle, Condition A			90	75	Off.

Notes:

[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).

[2] When Digital Compressor duty cycle, variable-speed speed ratio, or staged compressor displacement ratio for intermediate capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

TABLE 13—TEST OPERATING CONDITIONS FOR VARIABLE- OR MULTIPLE-CAPACITY LOW-TEMPERATURE OUTDOOR DEDICATED CONDENSING UNITS

Test title	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor operating mode
Capacity, Condition A, Minimum Capacity.	−19	32	95	75	Minimum Capacity, k=1.
Capacity, Condition A, Intermediate Capacity.	Unit Cooler Low Fan: [2] −22.5 Unit Cooler High Fan: [2] −19.5	13 13	95	75	Minimum Capacity, k=i.
Capacity, Condition A, Maximum Capacity.	−22	5	95	75	Maximum Capacity, k=2.
Off Cycle, Condition A			95	75	Compressor Off.

TABLE 13—TEST OPERATING CONDITIONS FOR VARIABLE- OR MULTIPLE-CAPACITY LOW-TEMPERATURE OUTDOOR DEDICATED CONDENSING UNITS—Continued

Test title	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor operating mode
Capacity, Condition B, Minimum Capacity.	−19	28	59	54	Minimum Capacity, k=1.
Capacity, Condition B, Intermediate Capacity.	Unit Cooler Low Fan: [2] −22.5 Unit Cooler High Fan: [2] −19.5	12 13	59	54	Minimum Capacity, k=i.
Capacity, Condition B, Maximum Capacity.	−22	5	59	54	Maximum Capacity, k=2.
Off Cycle, Condition B			59	54	Compressor Off.
Capacity, Condition C, Minimum Capacity.	−19	23	35	34	Minimum Capacity, k=1.
Capacity, Condition C, Intermediate Capacity.	Unit Cooler Low Fan: [2] −22.5 Unit Cooler High Fan: [2] −19.5	11 12	35	34	Minimum Capacity, k=i.
Capacity, Condition C, Maximum Capacity.	−22	5	35	34	Maximum Capacity, k=2.
Off Cycle, Condition C			35	34	Compressor Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] When Digital Compressor duty cycle, variable-speed speed ratio, or staged compressor displacement ratio for intermediate capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

TABLE 14—TEST OPERATING CONDITIONS FOR VARIABLE- OR MULTIPLE-CAPACITY LOW-TEMPERATURE INDOOR DEDICATED CONDENSING UNITS

Test title	Suction dew point, °F	Return gas, °F	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F [1]	Compressor operating mode
Capacity, Condition A, Minimum Capacity.	−19	32	90	75	Minimum Capacity, k=1.
Capacity, Condition A, Intermediate Capacity.	Unit Cooler Low Fan: [2] −22.5 Unit Cooler High Fan: [2] −19.5	13 13	90	75	Minimum Capacity, k=i.
Capacity, Condition A, Maximum Capacity.	−22	5	90	75	Maximum Capacity, k=2.
Off Cycle, Condition A			90	75	Compressor Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] When Digital Compressor duty cycle, variable-speed speed ratio, or staged compressor displacement ratio for intermediate capacity is 65% or less, use the Unit Cooler Low Fan condition, otherwise use the Unit cooler High Fan condition.

4.5.5 Test Operating Conditions for Two-Capacity Indoor Matched-Pair or Single-Packaged Refrigeration Systems.

For two-capacity indoor medium-temperature matched-pair or single-packaged refrigeration systems, conduct tests using the test conditions specified in Table 15 of this appendix. For two-capacity indoor low-temperature matched-pair or single-packaged refrigeration systems, conduct tests using the test conditions specified in Table 16 of this appendix.

TABLE 15—TEST OPERATING CONDITIONS FOR TWO-CAPACITY MEDIUM-TEMPERATURE INDOOR MATCHED-PAIR OR SINGLE-PACKAGED REFRIGERATION SYSTEMS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F	Compressor status
Capacity, Condition A, Low Capacity	35	<50	90	75,[1] 65[2]	Low Capacity.
Capacity, Condition A, High Capacity	35	<50	90	75,[1] 65[2]	High Capacity.
Off Cycle, Condition A	35	<50	90	75,[1] 65[2]	Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] Maximum allowable value for Single-Packaged Systems that do not use evaporative Dedicated Condensing Units, where all or part of the equipment is located in the outdoor room.

TABLE 16—TEST OPERATING CONDITIONS FOR TWO CAPACITY LOW-TEMPERATURE INDOOR MATCHED-PAIR OR SINGLE-PACKAGED REFRIGERATION SYSTEMS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Condenser air entering dry-bulb, °F	Maximum condenser air entering wet-bulb, °F	Compressor status
Capacity, Condition A, Low Capacity	−10	<50	90	75,[1] 65[2]	Low Capacity.
Capacity, Condition A, High Capacity	−10	<50	90	75,[1] 65[2]	High Capacity.
Off Cycle, Condition A	−10	<50	90	75,[1] 65[2]	Off.
Defrost	−10	<50			System Dependent.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] Maximum allowable value for Single-Packaged Systems that do not use evaporative Dedicated Condensing Units, where all or part of the equipment is located in the outdoor room.

4.5.6 Test Conditions for Variable- or Multiple-Capacity Indoor Matched Pair or Single-Packaged Refrigeration Systems.

For variable- or multiple-capacity indoor medium-temperature matched-pair or single-packaged refrigeration systems, conduct tests using the test conditions specified in Table 17 of this appendix. For variable- or multiple-capacity indoor low-temperature matched-pair or single-packaged refrigeration systems, conduct tests using the test conditions specified in Table 18 of this appendix.

TABLE 17—TEST OPERATING CONDITIONS FOR VARIABLE- OR MULTIPLE-CAPACITY MEDIUM-TEMPERATURE INDOOR MATCHED-PAIR OR SINGLE-PACKAGED REFRIGERATION SYSTEMS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Condenser air entering dry-bulb, °F	Condenser air entering wet-bulb, °F	Compressor status
Capacity, Condition A, Minimum Capacity	35	<50	90	75,[1] 65[2]	Minimum Capacity.
Capacity, Condition A, Intermediate Capacity	35	<50	90	75,[1] 65[2]	Intermediate Capacity.
Capacity, Condition A, High Capacity	35	<50	90	75,[1] 65[2]	Maximum Capacity.
Off Cycle, Condition A	35	<50	90	75,[1] 65[2]	Off.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] Maximum allowable value for Single-Packaged Systems that do not use evaporative Dedicated Condensing Units, where all or part of the equipment is located in the outdoor room.

TABLE 18—TEST OPERATING CONDITIONS FOR VARIABLE- OR MULTIPLE-CAPACITY LOW-TEMPERATURE INDOOR MATCHED-PAIR OR SINGLE-PACKAGED REFRIGERATION SYSTEMS

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Condenser air entering dry-bulb, °F	Maximum condenser air entering wet-bulb, °F	Compressor status
Capacity, Condition A, Minimum Capacity	−10	<50	90	75,[1] 65[2]	Minimum Capacity.
Capacity, Condition A, Intermediate Capacity	−10	<50	90	75,[1] 65[2]	Intermediate Capacity.
Capacity, Condition A, Maximum Capacity	−10	<50	90	75,[1] 65[2]	Maximum Capacity.
Off Cycle, Condition A	−10	<50	90	75,[1] 65[2]	Off.
Defrost	−10	<50			System Dependent.

Notes:
[1] Required only for evaporative condensing units (*e.g.,* incorporates a slinger ring).
[2] Maximum allowable value for Single-Packaged Systems that do not use evaporative Dedicated Condensing Units, where all or part of the equipment is located in the outdoor room.

4.6. Calculation for Walk-in Box Load.

4.6.1 For medium- and low-temperature refrigeration systems with indoor condensing units, calculate walk-in box loads for high and low load periods as a function of net capacity as described in Section 6.2.1 of AHRI 1250–2020.

4.6.2 For medium- and low-temperature refrigeration systems with outdoor condensing units, calculate walk-in box loads for high and low load periods as a function of net capacity and outdoor temperature as described in Section 6.2.2 of AHRI 1250–2020.

4.6.3 For high-temperature refrigeration systems, calculate walk-in box load as follows.

$\dot{B}L = \cdot\ \dot{q}_{ss,A}$

Where $\dot{q}_{ss,A}$ is the measured net capacity for Test Condition A.

4.7. Calculation for Annual Walk-in Energy Factor (AWEF).

Calculations used to determine AWEF based on performance data obtained for testing shall be as specified in Section 7 of AHRI 1250–2020 with modifications as indicated in sections 4.7.7 through 4.7.10 of this appendix. Calculations used to determine AWEF for refrigeration systems not specifically identified in Sections 7.1.1 through 7.1.6 of AHRI 1250–2020 are enumerated in sections 4.7.1 through 4.7.6 and sections 4.7.11 through 4.7.14 of this appendix.

4.7.1 Two-Capacity Condensing Units Tested Alone, Indoor.

4.7.1.1 Unit Cooler Power.

Calculate maximum-capacity unit cooler power during the compressor on period $\dot{E}F_{comp,on}$, in Watts, using Equation 130 of AHRI 1250–2020 for medium-temperature refrigeration systems and using Equation 173 of AHRI 1250–2020 for low-temperature refrigeration systems.

Calculate unit cooler power during the compressor off period $\dot{E}F_{comp,off}$, in Watts, as 20 percent of the maximum-capacity unit cooler power during the compressor on period.

4.7.1.2 Defrost.

For freezer refrigeration systems, calculate defrost heat contribution $\dot{Q}_{DF}$ in Btu/h and the defrost average power consumption $\dot{D}F$ in W as a function of steady-state maximum gross refrigeration capacity $\dot{Q}$, as specified in Section C10.2.2 of Appendix C of AHRI 1250–2020.

4.7.1.3 Net Capacity.

Calculate steady-state maximum net capacity, $\dot{q}$, and minimum net capacity, $\dot{q}$ as follows:

$\dot{q}\ = \dot{Q}\ - 3.412 \cdot \dot{E}F_{comp,on}$

$\dot{q}\ = \dot{Q}\ - 3.412 \cdot 0.2 \cdot \dot{E}F_{comp,on}$

Where:

$\dot{Q}$, and $\dot{Q}$, represent gross refrigeration capacity at maximum and minimum capacity, respectively.

4.7.1.4 Calculate average power input during the low load period as follows.

If the low load period box load, $B\dot{L}L$, plus defrost heat contribution, $\dot{Q}_{DF}$ (only applicable for freezers), is less than the minimum net capacity $\dot{q}$:

$$LFL^{k=1} = \frac{B\dot{L}L + 3.412 \cdot \dot{EF}_{comp,off} + \dot{Q}_{DF}}{\dot{q}_{ss}^{k=1} + 3.412 \cdot \dot{EF}_{comp,off}}$$

$$\dot{E}_L = \left(\dot{E}_{ss}^{k=1} + 0.2 \cdot \dot{EF}_{comp,on}\right) * LFL^{k=1} + \left(\dot{EF}_{comp,off} + \dot{E}_{cu,off}\right) * (1 - LFL^{k=1})$$

Where:

$\dot{E}$ is the steady state condensing unit power input for minimum-capacity operation.

$\dot{E}_{cu,off}$ is the condensing unit off-cycle power input, measured as described in Section C3.5 of AHRI 1250–2020.

If the low load period box load, $B\dot{L}L$, plus defrost heat contribution, $\dot{Q}_{DF}$, (only applicable for freezers) is greater than the minimum net capacity $\dot{q}$:

$$LFL^{k=1} = \frac{\dot{q}_{ss}^{k=2} - (B\dot{L}L + \dot{Q}_{DF})}{\dot{q}_{ss}^{k=2} - \dot{q}_{ss}^{k=1}}$$

$$LFL^{k=2} = 1 - LFL^{k=1}$$

$$\dot{E}_L = \left(\dot{E}_{ss}^{k=1} + 0.2 \cdot \dot{EF}_{comp,on}\right) * LFL^{k=1} + \left(\dot{E}_{ss}^{k=2} + \dot{EF}_{comp,on}\right) * LFL^{k=2}$$

4.1.7.5 Calculate average power input during the high load period as follows.

$$LFH^{k=1} = \frac{\dot{q}_{ss}^{k=2} - (B\dot{L}H + \dot{Q}_{DF})}{\dot{q}_{ss}^{k=2} - \dot{q}_{ss}^{k=1}}$$

$$LFH^{k=2} = 1 - LFH^{k=1}$$

$$\dot{E}_H = \left(\dot{E}_{ss}^{k=1} + 0.2 \cdot E\dot{F}_{comp,on}\right) * LFH^{k=1} + \left(\dot{E}_{ss}^{k=2} + E\dot{F}_{comp,on}\right) * LFH^{k=2}$$

4.1.7.6 Calculate the AWEF as follows:

$$AWEF = \frac{0.33 \cdot B\dot{L}H + 0.67 \cdot B\dot{L}L}{0.33 \cdot \dot{E}_H + 0.67 \cdot \dot{E}_L + D\dot{F}}$$

4.7.2 Variable-Capacity or Multistage Condensing Units Tested Alone, Indoor.

4.7.2.1 Unit Cooler Power.

Calculate maximum-capacity unit cooler power during the compressor on period $\dot{E}F_{comp,on}$ as described in section 4.7.1.1 of this appendix.

Calculate unit cooler power during the compressor off period $\dot{E}F_{comp,off}$, in Watts, as 20 percent of the maximum-capacity unit cooler power during the compressor on period.

4.7.2.2 Defrost.

Calculate Defrost parameters as described in section 4.7.1.2 of this appendix.

4.7.2.3 Net Capacity.

Calculate steady-state maximum net capacity, $\dot{q}$, intermediate net capacity, $\dot{q}$, and minimum net capacity, $\dot{q}$, as follows:

$\dot{q}$ = $\dot{Q}$ − 3.412 · $\dot{E}F_{comp,on}$

$\dot{q}$ = $\dot{Q}$ − 3.412 · K_f $\dot{E}F_{comp,on}$

$\dot{q}$ = $\dot{Q}$ − 3.412 · 0.2 · $\dot{E}F_{comp,on}$

Where:

$\dot{Q}$, $\dot{Q}$, $\dot{Q}$, and represent gross refrigeration capacity at maximum, intermediate, and minimum capacity, respectively.

K_f is the unit cooler power coefficient for intermediate capacity operation, set equal to 0.2 to represent low-speed fan operation if the Duty Cycle for a Digital Compressor, the Speed Ratio for a Variable-Speed Compressor, or the Displacement Ratio for a Multi-Stage Compressor at Intermediate Capacity is 65% or less, and otherwise set equal to 1.0.

4.7.2.4 Calculate average power input during the low load period as follows.

If the low load period box load, $B\dot{L}L$, plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is less than the minimum net capacity:

$$LFL^{k=1} = \frac{B\dot{L}L + 3.412 \cdot E\dot{F}_{comp,off} + \dot{Q}_{DF}}{\dot{q}_{ss}^{k=1} + 3.412 \cdot E\dot{F}_{comp,off}}$$

$$\dot{E}_L = \left(\dot{E}_{ss}^{k=1} + 0.2 \cdot E\dot{F}_{comp,on}\right) * LFL^{k=1} + \left(E\dot{F}_{comp,off} + \dot{E}_{cu,off}\right) * (1 - LFL^{k=1})$$

Where $\dot{E}_{cu,off}$, in W, is the condensing unit off-mode power consumption, measured as described in Section C3.5 of AHRI 1250–2020.

If the low load period box load $B\dot{L}L$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is greater than the minimum net capacity and less than the intermediate net capacity $\dot{q}$:

$$EER_L = EER^{k=1} + \left(EER^{k=i} - EER^{k=1}\right) \frac{(B\dot{L}L + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}}{\dot{q}_{ss}^{k=i} - \dot{q}_{ss}^{k=1}}$$

$$\dot{E}_L = \frac{B\dot{L}L}{EER_L}$$

Where:

$EER^{k=1}$ is the minimum-capacity energy efficiency ratio, equal to $\dot{q}$ divided by $\dot{E}$ + $\dot{E}F_{comp,on}$; and

$EER^{k=i}$ is the intermediate-capacity energy efficiency ratio, equal to $\dot{q}$ divided by $\dot{E}$ + $\dot{E}F_{comp,on}$.

4.7.2.5 Calculate average power input during the high load period as follows:

If the high load period box load, $B\dot{L}H$, plus defrost heat contribution, $\dot{Q}_{DF}$ (only applicable for freezers), is greater than the minimum net capacity $\dot{q}$ and less than the intermediate net capacity $\dot{q}$:

$$EER_H = EER^{k=1} + \left(EER^{k=i} - EER^{k=1}\right) \frac{(B\dot{L}H + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}}{\dot{q}_{ss}^{k=i} - \dot{q}_{ss}^{k=1}}$$

$$\dot{E}_H = \frac{B\dot{L}H}{EER_H}$$

If the high load period box load, $B\dot{L}H$, plus defrost heat contribution, $\dot{Q}_{DF}$ (only applicable for freezers), is greater than the intermediate net capacity $\dot{q}$ and less than the maximum net capacity, $\dot{q}$:

$$EER_H = EER^{k=i} + \left(EER^{k=2} - EER^{k=i}\right) \frac{(B\dot{L}H + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=i}}{\dot{q}_{ss}^{k=2} - \dot{q}_{ss}^{k=i}}$$

$$\dot{E}_H = \frac{B\dot{L}H}{EER_H}$$

Where:

$EER^{k=2}$ is the maximum-capacity energy efficiency ratio, equal to $\dot{q}$ divided by $\dot{E}$ + $\dot{E}F_{comp,on}$

4.7.2.6 Calculate the AWEF as follows.

$$AWEF = \frac{0.33 \cdot B\dot{L}H + 0.67 \cdot B\dot{L}L}{0.33 \cdot \dot{E}_H + 0.67 \cdot \dot{E}_L + \dot{DF}}$$

4.7.3 Two-Capacity Condensing Units Tested Alone, Outdoor.

4.7.3.1 Unit Cooler Power.

Calculate maximum-capacity unit cooler power during the compressor on period $\dot{E}F_{comp,on}$, in Watts, using Equation 153 of AHRI 1250–2020 for medium-temperature refrigeration systems and using Equation 196 of AHRI 1250–2020 for low-temperature refrigeration systems.

Calculate unit cooler power during the compressor off period $\dot{E}F_{comp,off}$, in Watts, as 20 percent of the maximum-capacity unit cooler power during the compressor on period.

4.7.3.2 Defrost.

Calculate Defrost parameters as described in section 4.7.1.2.

4.7.3.3 Condensing Unit Off-Cycle Power.

Calculate Condensing Unit Off-Cycle Power for temperature t_j as follows.

$$\dot{E}_{cu,off}(t_j) = \begin{cases} \dot{E}_{cu,off,A} & if\ t_j \geq 95\ °F \\ See\ note\ below & if\ 35\ °F < t_j < 95°F \\ \dot{E}_{cu,off,C} & if\ t_j \leq 35°F \end{cases}$$

Where $\dot{E}_{cu,off,A}$ and $\dot{E}_{cu,off,C}$ are the Condensing Unit off-cycle power measurements for test conditions A and C, respectively, measured as described in Section C3.5 of AHRI 1250–2020. If t_j is greater than 35 °F and less than 59 °F, use Equation 157 of AHRI 1250–2020, and if t_j is greater than or equal to 59 °F and less than 95 °F, use Equation 159.

4.7.3.4 Net Capacity and Condensing Unit Power Input.

Calculate steady-state maximum net capacity, $\dot{q}$ (t_j), and minimum net capacity, $\dot{q}$ (t_j), and corresponding condensing unit power input levels $\dot{E}$ (t_j) and $\dot{E}$ (t_j) as a function of outdoor temperature t_j as follows:

If 35 °F < t_j ≤ 59 °F:

$$\dot{q}_{ss}^{k=2}(t_j) = \dot{Q}_{gross,C}^{k=2} + \left(\dot{Q}_{gross,B}^{k=2} - \dot{Q}_{gross,C}^{k=2}\right)\frac{t_j - 35}{59 - 35} - 3.412 \cdot \dot{EF}_{comp,on}$$

$$\dot{q}_{ss}^{k=1}(t_j) = \dot{Q}_{gross,C}^{k=1} + \left(\dot{Q}_{gross,B}^{k=1} - \dot{Q}_{gross,C}^{k=1}\right)\frac{t_j - 35}{59 - 35} - 3.412 \cdot 0.2 \cdot \dot{EF}_{comp,on}$$

$$\dot{E}_{ss}^{k}(t_j) = \dot{E}_{ss,C}^{k} + \left(\dot{E}_{ss,B}^{k} - \dot{E}_{ss,C}^{k}\right)\frac{t_j - 35}{59 - 35}$$

If 59 °F ≥ t_j > 95 °F:

$$\dot{q}_{ss}^{k=2}(t_j) = \dot{Q}_{gross,B}^{k=2} + \left(\dot{Q}_{gross,A}^{k=2} - \dot{Q}_{gross,B}^{k=2}\right)\frac{t_j - 59}{95 - 59} - 3.412 \cdot \dot{EF}_{comp,on}$$

$$\dot{q}_{ss}^{k=1}(t_j) = \dot{Q}_{gross,B}^{k=1} + \left(\dot{Q}_{gross,A}^{k=1} - \dot{Q}_{gross,B}^{k=1}\right)\frac{t_j - 59}{95 - 59} - 3.412 \cdot 0.2 \cdot \dot{EF}_{comp,on}$$

$$\dot{E}_{ss}^{k}(t_j) = \dot{E}_{ss,B}^{k} + \left(\dot{E}_{ss,A}^{k} - \dot{E}_{ss,B}^{k}\right)\frac{t_j - 59}{95 - 59}$$

Where:

The capacity level k can equal 1 or 2;

$\dot{Q}$ and $\dot{Q}$ represent gross refrigeration capacity at maximum and minimum capacity, respectively, for test condition X, which can take on values A, B, or C;

$\dot{E}$ and $\dot{E}$ represent condensing unit power input at maximum and minimum capacity, respectively for test condition X.

4.7.3.5 Calculate average power input during the low load period as follows.

Calculate the temperature, t_{IL}, below which the low load period box load, $\dot{BLL}(t_j)$, plus defrost heat contribution, $\dot{Q}_{DF}$ (only applicable for freezers), is less than the minimum net capacity, $\dot{q}\,(t_j)$, by solving the following equation for t_{IL}:

$\dot{BLL}(t_{IL}) + \dot{Q}_{DF} = \dot{q}\,(t_{IL})$

For $t_j < t_{IL}$:

$$LFL^{k=1}(t_j) = \frac{\dot{BLL}(t_j) + 3.412 \cdot \dot{EF}_{comp,off} + \dot{Q}_{DF}}{\dot{q}_{ss}^{k=1}(t_j) + 3.412 \cdot \dot{EF}_{comp,off}}$$

$$\dot{E}_L(t_j) = \left(\dot{E}_{ss}^{k=1}(t_j) + 0.2 \cdot \dot{EF}_{comp,on}\right) * LFL^{k=1}(t_j) + \left(\dot{EF}_{comp,off} + \dot{E}_{cu,off}(t_j)\right) * \left(1 - LFL^{k=1}(t_j)\right)$$

Where $\dot{E}_{cu,off}(t_j)$, in W, is the condensing unit off-mode power consumption for temperature t_j, determined as indicated in section 4.7.3.3 of this appendix.

For $t_j \geq t_{IL}$:

$$LFL^{k=1}(t_j) = \frac{\dot{q}_{ss}^{k=2}(t_j) - (\dot{BLL}(t_j) + \dot{Q}_{DF})}{\dot{q}_{ss}^{k=2}(t_j) - \dot{q}_{ss}^{k=1}(t_j)}$$

$$LFL^{k=2}(t_j) = 1 - LFL^{k=1}(t_j)$$

$$\dot{E}_L(t_j) = \left(\dot{E}_{ss}^{k=1}(t_j) + 0.2 \cdot \dot{EF}_{comp,on}\right) * LFL^{k=1}(t_j) + \left(\dot{E}_{ss}^{k=2}(t_j) + \dot{EF}_{comp,on}\right) * LFL^{k=2}(t_j)$$

4.7.3.6 Calculate average power input during the high load period as follows.

Calculate the temperature, t_{IH}, below which the high load period box load, $\dot{BLH}(t_j)$, plus defrost heat contribution, $\dot{Q}_{DF}$ (only applicable for freezers), is less than the minimum net capacity, $\dot{q}\,(t_j)$, by solving the following equation for t_{IH}:

$B\dot{L}H(t_{IH}) + \dot{Q}_{DF} = \dot{q}\,(t_{IH})$

Calculate the temperature, t_{IIH}, below which the high load period box load $B\dot{L}H(t_j)$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is less than the maximum net capacity $\dot{q}\,(t_j)$, by solving the following equation for t_{IIH}:

$B\dot{L}H(t_{IH}) + \dot{Q}_{DF} = \dot{q}\,(t_{IIH})$

For $t_j < t_{IH}$:

$$LFH^{k=1}(t_j) = \frac{B\dot{L}H(t_j) + 3.412 \cdot \dot{EF}_{comp,off} + \dot{Q}_{DF}}{\dot{q}_{ss}^{k=1}(t_j) + 3.412 \cdot \dot{EF}_{comp,off}}$$

For $t_{IH} \le t_j < t_{IIH}$:

$$LFH^{k=1}(t_j) = \frac{\dot{q}_{ss}^{k=2}(t_j) - (B\dot{L}H(t_j) + \dot{Q}_{DF})}{\dot{q}_{ss}^{k=2}(t_j) - \dot{q}_{ss}^{k=1}(t_j)}$$

$$LFH^{k=2}(t_j) = 1 - LFH^{k=1}(t_j)$$

$$\dot{E}_H(t_j) = \left(\dot{E}_{ss}^{k=1}(t_j) + 0.2 \cdot \dot{EF}_{comp,on}\right) * LFH^{k=1}(t_j) + \left(\dot{E}_{ss}^{k=2}(t_j) + \dot{EF}_{comp,on}\right) * LFH^{k=2}(t_j)$$

For $t_{IIH} \le t_j$:

$\dot{E}_H(t_j) + (\dot{E}\,(t_j) + \dot{EF}_{comp,on}$

4.7.3.7 Calculate the AWEF as follows:

$$AWEF = \frac{\sum_{j=1}^{n}\left[0.33 \cdot B\dot{L}H(t_j) + 0.67 \cdot B\dot{L}L(t_j)\right] \cdot n_j}{\sum_{j=1}^{n}\left[0.33 \cdot \dot{E}_H(t_j) + 0.67 \cdot \dot{E}_L(t_j) + \dot{DF}\right] \cdot n_j}$$

4.7.4 Variable-Capacity or Multistage Condensing Units Tested Alone, Outdoor.

4.7.4.1 Unit Cooler Power.

Calculate maximum-capacity unit cooler power during the compressor on period $\dot{EF}_{comp,on}$ as described in section 4.7.1.1 of this appendix.

Calculate unit cooler power during the compressor off period $\dot{EF}_{comp,off}$, in Watts, as 20 percent of the maximum-capacity unit cooler power during the compressor on period.

4.7.4.2 Defrost.

Calculate Defrost parameters as described in section 4.7.1.2.

4.7.4.3 Condensing Unit Off-Cycle Power.

Calculate Condensing Unit Off-Cycle Power for temperature, t_j, as described in section 4.7.3.3 of this appendix.

4.7.4.4 Net Capacity and Condensing Unit Power Input.

Calculate steady-state maximum net capacity, $\dot{q}\,(t_j)$, intermediate net capacity, $\dot{q}\,(t_j)$, and minimum net capacity, $\dot{q}\,(t_j)$, and corresponding condensing unit power input levels $\dot{E}\,(t_j)$, $\dot{E}\,(t_j)$, and $\dot{E}\,(t_j)$ as a function of outdoor temperature, t_j, as follows:

If 35 °F > t_j ≥ 59 °F:

$$\dot{q}_{ss}^{k=2}(t_j) = \dot{Q}_{gross,C}^{k=2} + \left(\dot{Q}_{gross,B}^{k=2} - \dot{Q}_{gross,C}^{k=2}\right)\frac{t_j - 35}{59 - 35} - 3.412 \cdot \dot{EF}_{comp,on}$$

$$\dot{q}_{ss}^{k=i}(t_j) = \dot{Q}_{gross,C}^{k=i} + \left(\dot{Q}_{gross,B}^{k=i} - \dot{Q}_{gross,C}^{k=i}\right)\frac{t_j - 35}{59 - 35} - 3.412 \cdot K_f.\dot{EF}_{comp,on}$$

$$\dot{q}_{ss}^{k=1}(t_j) = \dot{Q}_{gross,C}^{k=1} + \left(\dot{Q}_{gross,B}^{k=1} - \dot{Q}_{gross,C}^{k=1}\right)\frac{t_j - 35}{59 - 35} - 3.412 \cdot 0.2 \cdot \dot{EF}_{comp,on}$$

$$\dot{E}_{ss}^{k}(t_j) = \dot{E}_{ss,C}^{k} + \left(\dot{E}_{ss,B}^{k} - \dot{E}_{ss,C}^{k}\right)\frac{t_j - 35}{59 - 35}$$

If 59 °F ≥ t_j > 95 °F:

$$\dot{q}_{ss}^{k=2}(t_j) = \dot{Q}_{gross,B}^{k=2} + \left(\dot{Q}_{gross,A}^{k=2} - \dot{Q}_{gross,B}^{k=2}\right)\frac{t_j - 59}{95 - 59} - 3.412 \cdot \dot{EF}_{comp,on}$$

$$\dot{q}_{ss}^{k=i}(t_j) = \dot{Q}_{gross,B}^{k=i} + \left(\dot{Q}_{gross,A}^{k=i} - \dot{Q}_{gross,B}^{k=i}\right)\frac{t_j - 59}{95 - 59} - 3.412 \cdot K_f \cdot \dot{EF}_{comp,on}$$

$$\dot{q}_{ss}^{k=1}(t_j) = \dot{Q}_{gross,B}^{k=1} + \left(\dot{Q}_{gross,A}^{k=1} - \dot{Q}_{gross,B}^{k=1}\right)\frac{t_j - 59}{95 - 59} - 3.412 \cdot 0.2 \cdot \dot{EF}_{comp,on}$$

$$\dot{E}_{ss}^{k}(t_j) = \dot{E}_{ss,B}^{k} + \left(\dot{E}_{ss,A}^{k} - \dot{E}_{ss,B}^{k}\right)\frac{t_j - 59}{95 - 59}$$

Where:

The capacity level k can equal 1, i, or 2;

$\dot{Q}$, $\dot{Q}$ and $\dot{Q}$ represent gross refrigeration capacity at maximum, intermediate, and minimum capacity, respectively, for test condition X, which can take on values A, B, or C;

$\dot{E}$ and $\dot{E}$ represent condensing unit power input at maximum and minimum capacity, respectively for test condition X; and

K_f is the unit cooler power coefficient for intermediate capacity operation, set equal to 0.2 to represent low-speed fan operation if the Duty Cycle for a Digital Compressor, the Speed Ratio for a Variable-Speed Compressor, or the Displacement Ratio for a Multi-Stage Compressor at Intermediate Capacity is 65% or less, and otherwise set equal to 1.0.

4.7.4.5 Calculate average power input during the low load period as follows.

Calculate the temperature, t_{IL}, below which the low load period box load $B\dot{L}L(t_j)$ plus defrost heat contribution, $\dot{Q}_{DF}$ (only applicable for freezers), is less than the minimum net capacity, $\dot{q}\ (t_j)$, by solving the following equation for t_{IL}:

$B\dot{L}L(t_{IL}) + \dot{q}\ (t_{IL})$

Calculate the temperature, t_{VL}, below which the low load period box load, $B\dot{L}L(t_j)$, plus defrost heat contribution, $\dot{Q}_{DF}$ (only applicable for freezers), is less than the intermediate net capacity, $\dot{q}\ (t_j)$, by solving the following equation for t_{VL}:

$B\dot{L}L(t_{VL}) + \dot{Q}_{DF} = \dot{q}\ (t_{VL})$

For $t_j < t_{IL}$:

$$LFL^{k=1}(t_j) = \frac{B\dot{L}L(t_j) + 3.412 \cdot \dot{EF}_{comp,off} + \dot{Q}_{DF}}{\dot{q}_{ss}^{k=1}(t_j) + 3.412 \cdot \dot{EF}_{comp,off}}$$

$$\dot{E}_L(t_j) = \left(\dot{E}_{ss}^{k=1}(t_j) + 0.2 \cdot \dot{EF}_{comp,on}\right) * LFL^{k=1}(t_j) + \left(\dot{EF}_{comp,off} + \dot{E}_{cu,off}(t_j)\right) * \left(1 - LFL^{k=1}(t_j)\right)$$

Where $\dot{E}_{cu,off}(t_j)$, in W, is the condensing unit off-mode power consumption for temperature, t_j, determined as indicated in section 4.7.3.3 of this appendix.

For $t_{IL} \le t_j < t_{VL}$:

$$EER_L(t_j) = EER^{k=1}(t_j) + \left(EER^{k=i}(t_j) - EER^{k=1}(t_j)\right)\frac{(B\dot{L}L(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}(t_j)}{\dot{q}_{ss}^{k=i}(t_j) - \dot{q}_{ss}^{k=1}(t_j)}$$

$$\dot{E}_L(t_j) = \frac{B\dot{L}L(t_j)}{EER_L(t_j)}$$

For $t_{VL} \le t_j$:

$$EER_L(t_j) = EER^{k=i}(t_j) + \left(EER^{k=2}(t_j) - EER^{k=i}(t_j)\right)\frac{(B\dot{L}L(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=i}(t_j)}{\dot{q}_{ss}^{k=2}(t_j) - \dot{q}_{ss}^{k=i}(t_j)}$$

$$\dot{E}_L(t_j) = \frac{B\dot{L}L(t_j)}{EER_L(t_j)}$$

Where:

$EER^{k=1}(t_j)$ is the minimum-capacity energy efficiency ratio, equal to $\dot{q}\ (t_j)$ divided by $\dot{E}\ (t_j) + 0.2 \cdot \dot{EF}_{comp,on}$;

$EER^{k=i}(t_j)$ is the intermediate-capacity energy efficiency ratio, equal to $\dot{q}\ (t_j)$ divided by $\dot{E}_{ss}{}^{k=i}(t_j) + K_f \cdot \dot{EF}_{comp,on}$; and

$EER^{k=2}(t_j)$ is the maximum-capacity energy efficiency ratio, equal to $\dot{q}\ (t_j)$ divided by $\dot{E}\ (t_j) + \dot{EF}_{comp,on}$

4.7.4.6 Calculate average power input during the high load period as follows.

Calculate the temperature t_{VH} below which the high load period box load $B\dot{L}H(t_j)$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is less than the intermediate net capacity $\dot{q}\ (t_j)$, by solving the following equation for t_{VH}:

$B\dot{L}H(t_{VH}) + \dot{Q}_{DF} = \dot{q}_{ss}{}^{k=i}(t_{VH})$

Calculate the temperature t_{IIH} below which the high load period box load $B\dot{L}H(t_j)$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is less than the maximum net capacity $\dot{q}\ (t_j)$, by solving the following equation for t_{IIH}:

$B\dot{L}H(t_{IIH}) + \dot{Q}_{DF} = \dot{q}\ \ (t_{IIH})$

For $t_j < t_{VH}$:

$$EER_H(t_j) = EER^{k=1}(t_j) + \left(EER^{k=i}(t_j) - EER^{k=1}(t_j)\right) \frac{(B\dot{L}H(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}(t_j)}{\dot{q}_{ss}^{k=i}(t_j) - \dot{q}_{ss}^{k=1}(t_j)}$$

$$\dot{E}_H(t_j) = \frac{B\dot{L}H(t_j)}{EER_H(t_j)}$$

For $t_{VH} \le t_j < t_{IIH}$:

$$EER_H(t_j) = EER^{k=i}(t_j) + \left(EER^{k=2}(t_j) - EER^{k=i}(t_j)\right) \frac{(B\dot{L}H(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=i}(t_j)}{\dot{q}_{ss}^{k=2}(t_j) - \dot{q}_{ss}^{k=i}(t_j)}$$

$$\dot{E}_H(t_j) = \frac{B\dot{L}H(t_j)}{EER_H(t_j)}$$

For $t_{IIH} \le t_j$:

$\dot{E}_H(t_j) = (\dot{E}\ (t_j) + \dot{EF}_{comp,on})$

4.7.4.7 Calculate the AWEF as follows:

$$AWEF = \frac{\sum_{j=1}^{n}\left[0.33 \cdot B\dot{L}H(t_j) + 0.67 \cdot B\dot{L}L(t_j)\right] \cdot n_j}{\sum_{j=1}^{n}\left[0.33 \cdot \dot{E}_H(t_j) + 0.67 \cdot \dot{E}_L(t_j) + \dot{DF}\right] \cdot n_j}$$

4.7.5 Two-Capacity Indoor Matched Pairs or Single-Packaged Refrigeration Systems Other than High-Temperature.

4.7.5.1 Defrost.

For freezer refrigeration systems, defrost heat contribution $\dot{Q}_{DF}$ in Btu/h and the defrost average power consumption $\dot{DF}$ in W shall be as measured in accordance with Section C10.2.1 of Appendix C of AHRI 1250–2020.

4.7.5.2 Calculate average power input during the low load period as follows.

If the low load period box load $B\dot{L}L$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is less than the minimum net capacity $\dot{q}$:

$$LFL^{k=1} = \frac{B\dot{L}L + 3.412 \cdot \dot{EF}_{comp,off} + \dot{Q}_{DF}}{\dot{q}_{ss}^{k=1} + 3.412 \cdot \dot{EF}_{comp,off}}$$

$$\dot{E}_L = \left(\dot{E}_{ss}^{k=1}\right) * LFL^{k=1} + \left(\dot{EF}_{comp,off} + \dot{E}_{cu,off}\right) * (1 - LFL^{k=1})$$

Where:

$\dot{q}$ and $\dot{E} \le$ are the steady state refrigeration system minimum net capacity, in Btu/h, and associated refrigeration system power input, in W, respectively, for minimum-capacity operation, measured as described in AHRI 1250–2020.

$\dot{EF}_{comp,off}$ and $\dot{E}_{cu,off}$, both in W, are the unit cooler and condensing unit, respectively, off-mode power consumption, measured as described in Section C3.5 of AHRI 1250–2020.

If the low load period box load $B\dot{L}L$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is greater than the minimum net capacity $\dot{q}$:

$$LFL^{k=1} = \frac{\dot{q}_{ss}^{k=2} - (\dot{BLL} + \dot{Q}_{DF})}{\dot{q}_{ss}^{k=2} - \dot{q}_{ss}^{k=1}}$$

$$LFL^{k=2} = 1 - LFL^{k=1}$$

$$\dot{E}_L = \left(\dot{E}_{ss}^{k=1}\right) * LFL^{k=1} + \left(\dot{E}_{ss}^{k=2}\right) * LFL^{k=2}$$

Where $\dot{q}$ and $\dot{E}$ are the steady state refrigeration system maximum net capacity, in Btu/h, and associated refrigeration system power input, in W, respectively, for maximum-capacity operation, measured as described in AHRI 1250–2020.

4.7.5.3 Calculate average power input during the high load period as follows.

$$LFH^{k=1} = \frac{\dot{q}_{ss}^{k=2} - (\dot{BLH} + \dot{Q}_{DF})}{\dot{q}_{ss}^{k=2} - \dot{q}_{ss}^{k=1}}$$

$$LFH^{k=2} = 1 - LFH^{k=1}$$

$$\dot{E}_H = \left(\dot{E}_{ss}^{k=1}\right) * LFH^{k=1} + \left(\dot{E}_{ss}^{k=2}\right) * LFH^{k=2}$$

4.7.5.4 Calculate the AWEF as follows:

$$AWEF = \frac{0.33 \cdot \dot{BLH} + 0.67 \cdot \dot{BLL}}{0.33 \cdot \dot{E}_H + 0.67 \cdot \dot{E}_L + \dot{DF}}$$

4.7.6 Variable-Capacity or Multistage Indoor Matched Pairs or Single-Packaged Refrigeration Systems Other than High-Temperature.

4.7.6.1 Defrost.

For freezer refrigeration systems, defrost heat contribution in Btu/h and the defrost average power consumption in W shall be as measured in accordance with Section C10.2.1 of Appendix C of AHRI 1250–2020.

4.7.6.2 Calculate average power input during the low load period as follows.

If the low load period box load $\dot{BLL}$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is less than the minimum net capacity $\dot{q}$

$$LFL^{k=1} = \frac{\dot{BLL} + 3.412 \cdot \dot{EF}_{comp,off} + \dot{Q}_{DF}}{\dot{q}_{ss}^{k=1} + 3.412 \cdot \dot{EF}_{comp,off}}$$

$$\dot{E}_L = \left(\dot{E}_{ss}^{k=1}\right) * LFL^{k=1} + \left(\dot{EF}_{comp,off} + \dot{E}_{cu,off}\right) * (1 - LFL^{k=1})$$

Where:

$\dot{q}$ and $\dot{E}$ are the steady state refrigeration system minimum net capacity, in Btu/h, and associated refrigeration system power input, in W, respectively, for minimum-capacity operation, measured as described in AHRI 1250–2020; and

$\dot{EF}_{comp,off}$ and $\dot{E}_{cu,off}$, both in W, are the unit cooler and condensing unit, respectively, off-mode power consumption, measured as described in Section C3.5 of AHRI 1250–2020.

If the low load period box load $\dot{BLL}$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is greater than the minimum net capacity $\dot{q}$ and less than the intermediate net capacity $\dot{q}$:

$$EER_L = EER^{k=1} + \left(EER^{k=i} - EER^{k=1}\right) \frac{(\dot{BLL} + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}}{\dot{q}_{ss}^{k=i} - \dot{q}_{ss}^{k=1}}$$

$$\dot{E}_L = \frac{\dot{BLL}}{EER_L}$$

Where:

$EER^{k=1}$ is the minimum-capacity energy efficiency ratio, equal to $\dot{q}$ divided by $\dot{E}$;

$\dot{q}$ and $\dot{E}$ are the steady state refrigeration system intermediate net capacity, in Btu/h, and associated refrigeration system power input, in W, respectively, for intermediate-capacity operation, measured as described in AHRI 1250–2020.

$EER^{k=i}$ is the intermediate-capacity energy efficiency ratio, equal to $\dot{q}$ divided by $\dot{E}$.

4.7.6.3 Calculate average power input during the high load period as follows.

If the high load period box load $B\dot{L}H$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is greater than the minimum net capacity $\dot{q}$ and less than the intermediate net capacity $\dot{q}$:

$$EER_H = EER^{k=1} + \left(EER^{k=i} - EER^{k=1}\right) \frac{(B\dot{L}H + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}}{\dot{q}_{ss}^{k=i} - \dot{q}_{ss}^{k=1}}$$

$$\dot{E}_H = \frac{B\dot{L}H}{EER_H}$$

If the high load period box load $B\dot{L}H$ plus defrost heat contribution $\dot{Q}_{DF}$ (only applicable for freezers) is greater than the intermediate net capacity $\dot{q}$ and less than the maximum net capacity $\dot{q}$:

$$EER_H = EER^{k=i} + \left(EER^{k=2} - EER^{k=i}\right) \frac{(B\dot{L}H + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=i}}{\dot{q}_{ss}^{k=2} - \dot{q}_{ss}^{k=i}}$$

$$\dot{E}_H = \frac{B\dot{L}H}{EER_H}$$

Where:

$\dot{q}$ and $\dot{E}$ are the steady state refrigeration system maximum net capacity, in Btu/h, and associated refrigeration system power input, in W, respectively, for maximum-capacity operation, measured as described in AHRI 1250–2020; and

$EER^{k=2}$ is the maximum-capacity energy efficiency ratio, equal to $\dot{q}$ divided by $\dot{E}$.

4.7.6.4 Calculate the AWEF as follows.

$$AWEF = \frac{0.33 \cdot B\dot{L}H + 0.67 \cdot B\dot{L}L}{0.33 \cdot \dot{E}_H + 0.67 \cdot \dot{E}_L + \dot{DF}}$$

4.7.7 Variable-Capacity or Multistage Outdoor Matched Pairs or Single-Packaged Refrigeration Systems Other than High-Temperature.

Calculate AWEF as described in Section 7.6 of AHRI 1250–2020, with the following revisions.

4.7.7.1 Condensing Unit Off-Cycle Power.

Calculate condensing unit off-cycle power for temperature t_j as indicated in section 4.7.3.3 of this appendix. Replace the constant value $\dot{E}_{CU,off}$ in Equations 55 and 70 of AHRI 1250–2020 with the values $\dot{E}_{CU,off}(t_j)$, which vary with outdoor temperature t_j.

4.7.7.2 Unit Cooler Off-Cycle Power.

Set unit cooler Off-Cycle power $\dot{E}F_{comp,off}$ equal to the average of the unit cooler off-cycle power measurements made for test conditions A, B, and C.

4.7.7.3 Average Power During the Low Load Period.

Calculate average power for intermediate-capacity compressor operation during the low load period $\dot{E}_{ss,L}{}^{k=v}(t_j)$ as described in Section 7.6 of AHRI 1250–2020, except that, instead of calculating intermediate-capacity compressor EER using Equation 77, calculate EER as follows.

For $t_j < t_{VL}$:

$$\dot{E}_{ss,L}^{k=v}(t_j) = EER^{k=1}(t_j) + \left(EER^{k=i}(t_j) - EER^{k=1}(t_j)\right) \frac{(B\dot{L}L(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}(t_j)}{\dot{q}_{ss}^{k=i}(t_j) - \dot{q}_{ss}^{k=1}(t_j)}$$

For $t_{VL} \leq t_j$:

$$\dot{E}_{ss,L}^{k=v}(t_j) = EER^{k=i}(t_j) + \left(EER^{k=2}(t_j) - EER^{k=i}(t_j)\right) \frac{(B\dot{L}L(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=i}(t_j)}{\dot{q}_{ss}^{k=2}(t_j) - \dot{q}_{ss}^{k=i}(t_j)}$$

Where:

$EER^{k=1}(t_j)$ is the minimum-capacity energy efficiency ratio, equal to $\dot{q}(t_j)$ divided by $\dot{E}^{k=1}(t_j)$;

$EER^{k=i}(t_j)$ is the intermediate-capacity energy efficiency ratio, equal to $\dot{q}(t_j)$ divided by $\dot{E}(t_j)$; and

$EER^{k=2}(t_j)$ is the maximum-capacity energy efficiency ratio, equal to $\dot{q}(t_j)$ divided by $\dot{E}(t_j)$

4.7.7.4 Average Power During the High Load Period.

Calculate average power for intermediate-capacity compressor operation during the high load period $\dot{E}(t_j)$ as described in Section 7.6 of AHRI 1250–2020, except that, instead of calculating intermediate-capacity compressor EER using Equation 61, calculate EER as follows:

For $t_j < t_{VH}$:

$$EER_{ss,H}^{k=v}(t_j) = EER^{k=1}(t_j) + \left(EER^{k=i}(t_j) - EER^{k=1}(t_j)\right)\frac{(\dot{BLH}(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=1}(t_j)}{\dot{q}_{ss}^{k=i}(t_j) - \dot{q}_{ss}^{k=1}(t_j)}$$

For $t_{VH} \le t_j$:

$$EER_{ss,H}^{k=v}(t_j) = EER^{k=i}(t_j) + \left(EER^{k=2}(t_j) - EER^{k=i}(t_j)\right)\frac{(\dot{BLH}(t_j) + \dot{Q}_{DF}) - \dot{q}_{ss}^{k=i}(t_j)}{\dot{q}_{ss}^{k=2}(t_j) - \dot{q}_{ss}^{k=i}(t_j)}$$

4.7.8 Two-Capacity Outdoor Matched Pairs or Single-Packaged Refrigeration Systems Other than High-Temperature.

Calculate AWEF as described in Section 7.5 of AHRI 1250–2020, with the following revisions for Condensing Unit Off-Cycle Power and Unit Cooler Off-Cycle Power. Calculate condensing unit off-cycle power for temperature t_j as indicated in section 4.7.3.3 of this appendix. Replace the constant value $\dot{E}_{CU,off}$ in Equations 13 and 29 of AHRI 1250–2020 with the values $\dot{E}_{CU,off}(t_j)$, which vary with outdoor temperature (t_j. Set unit cooler Off-Cycle power $\dot{EF}_{comp,off}$ equal to the average of the unit cooler off-cycle power measurements made for test conditions A, B, and C.

4.7.9 Single-capacity Outdoor Matched Pairs or Single-Packaged Refrigeration Systems Other than High-Temperature.

Calculate AWEF as described in Section 7.4 of AHRI 1250–2020, with the following revision for Condensing Unit Off-Cycle Power and Unit Cooler Off-cycle Power. Calculate condensing unit off-cycle power for temperature t_j as indicated in section 4.7.3.3 of this appendix. Replace the constant value $\dot{E}_{CU,off}$ in Equations 13 of AHRI 1250–2020 with the values $\dot{E}_{CU,off}(t_j)$, which vary with outdoor temperature t_j. Set unit cooler Off-Cycle power $\dot{EF}_{comp,off}$ equal to the average of the unit cooler off-cycle power measurements made for test conditions A, B, and C.

4.7.10 Single-capacity Condensing Units, Outdoor.

Calculate AWEF as described in Section 7.9 of AHRI 1250–2020, with the following revision for Condensing Unit Off-Cycle Power. Calculate condensing unit off-cycle power for temperature t_j as indicated in section 4.7.3.3 of this appendix rather than as indicated in equations 157, 159, 202, and 204 of AHRI 1250–2020.

4.7.11 High-Temperature Matched Pairs or Single-Packaged Refrigeration Systems, Indoor.

4.7.11.1 Calculate Load Factor LF as follows:

$$LF = \frac{\dot{BL} + 3.412 \cdot \dot{EF}_{comp,off}}{\dot{q}_{ss,A} + 3.412 \cdot \dot{EF}_{comp,off}}$$

Where:

$\dot{BL}$, in Btu/h is the non-equipment-related box load calculated as described in section 4.6.3 of this appendix;

$\dot{EF}_{comp,off}$, in W, is the unit cooler off-cycle power consumption, equal to 0.1 times the unit cooler on-cycle power consumption; and

$\dot{q}_{ss,A}$, in Btu/h is the measured net capacity for test condition A.

4.7.11.2 Calculate the AWEF as follows:

$$AWEF = \frac{\dot{BL}}{\dot{E}_{ss,A} \cdot LF + \left(\dot{EF}_{comp,off} + \dot{E}_{cu,off}\right) \cdot (1 - LF)}$$

Where:

$\dot{E}_{ss,A}$, in W, is the measured system power input for test condition A; and

$\dot{E}_{cu,off}$, in W, is the condensing unit off-cycle power consumption, measured as described in Section C3.5 of AHRI 1250–2020.

4.7.12 High-Temperature Matched Pairs or Single-Packaged Refrigeration Systems, Outdoor.

4.7.12.1 Calculate Load Factor $LF(t_j)$ for outdoor temperature t_j as follows:

$$LF(t_j) = \frac{\dot{BL} + 3.412 \cdot \dot{EF}_{comp,off}}{\dot{q}_{ss}(t_j) + 3.412 \cdot \dot{EF}_{comp,off}}$$

Where:

$\dot{BL}$, in Btu/h, is the non-equipment-related box load calculated as described in section 4.6.3 of this appendix;

$\dot{EF}_{comp,off}$, in W, is the unit cooler off-cycle power consumption, equal to 0.1 times the unit cooler on-cycle power consumption; and

$\dot{q}_{ss}(t_j)$, in Btu/h, is the net capacity for outdoor temperature t_j, calculated as described in Section 7.4.2 of AHRI 1250–2020.

4.7.12.2 Calculate the AWEF as follows:

$$AWEF = \frac{\sum_{i=1}^{n} \dot{BL} \cdot n_j}{\sum_{j=1}^{n} \left[\dot{E}_{ss}(t_j) \cdot LF(t_j) + \left(\dot{EF}_{comp,off} + \dot{E}_{cu,off} \right) \cdot \left(1 - LF(t_j) \right) \right] \cdot n_j}$$

Where:

$\dot{E}_{ss}(t_j)$, in W, is the system power input for temperature t_j, calculated as described in Section 7.4.2 of AHRI 1250–2020;

$\dot{E}_{cu,off}$ in W, is the condensing unit off-cycle power consumption, measured as described in Section C3.5 of AHRI 1250–2020; and

n_j are the hours for temperature bin j.

4.7.13 High-Temperature Unit Coolers Tested Alone.

4.7.13.1 Calculate Refrigeration System Power Input as follows:

$$\dot{E}_{mix,rack} = \frac{\dot{q}_{mix,evap} + 3.412 \times \dot{EF}_{comp,on}}{EER} + \dot{EF}_{comp,on}$$

Where:

$\dot{q}_{mix,evap}$, in W, is the net evaporator capacity, measured as described in AHRI 1250–2020;

$\dot{EF}_{comp,on}$, in W, is the unit cooler on-cycle power consumption; and EER, in W, equals

$$\begin{cases} 11 & if\ \dot{q}_{mix,evap} < 10{,}000\ Btu/h \\ 0.0007 \cdot \dot{q}_{mix,evap} + 4 & if\ 10{,}000 \leq \dot{q}_{mix,evap} \leq 20{,}000\ Btu/h \\ 18 & if\ 20{,}000 \leq \dot{q}_{mix,evap} \end{cases}$$

4.7.13.2 Calculate the load factor LF as follows:

$$LF = \frac{\dot{BL} + 3.412 \cdot \dot{EF}_{comp,off}}{\dot{q}_{mix,evap} + 3.412 \cdot \dot{EF}_{comp,off}}$$

Where:

$\dot{BL}$, in Btu/h, is the non-equipment-related box load calculated as described in section 4.6.3 of this appendix; and

$\dot{EF}_{comp,off}$, in W, is the unit cooler off-cycle power consumption, equal to 0.1 times the unit cooler on-cycle power consumption.

4.7.13.3 Calculate AWEF as follows:

$$AWEF = \frac{\dot{BL}}{\dot{E}_{mix,rack} \cdot LF + \dot{EF}_{comp,off} \cdot (1 - LF)}$$

4.7.14 CO_2 Unit Coolers Tested Alone.

Calculate AWEF for CO_2 Unit Coolers Tested Alone using the calculations specified in in Section 7.8 of AHRI 1250–2020 for calculation of AWEF for Unit Cooler Tested Alone.

4.8. Test Method.

Test the Refrigeration System in accordance with AHRI 1250–2020 to determine refrigeration capacity and power input for the specified test conditions, with revisions and additions as described in this section.

4.8.1 Chamber Conditioning Using the Unit Under Test.

In Appendix C, Section C5.2.2 of AHRI 1250–2020, for applicable system configurations (matched pairs, single-packaged refrigeration systems, and standalone unit coolers), the unit under test may be used to aid in achieving the required test chamber conditions prior to beginning any steady state test. However, the unit under test must be inspected and confirmed to be free from frost before initiating steady state testing.

4.8.2 General Modification: Methods of Testing.

4.8.2.1 Refrigerant Temperature Measurements.

When testing a condensing unit alone, measure refrigerant liquid temperature leaving the condensing unit as required in Section C7.5.1.1.2 of Appendix C of AHRI 1250–2020 using the same measurement approach specified for the unit cooler in Section C3.1.3 of Appendix C of AHRI 1250–2020. In all cases in which thermometer wells or immersed sheathed sensors are prescribed, if the refrigerant tube outer diameter is less than ½ inch, the refrigerant temperature may be measured using the average of two temperature measuring instruments with a minimum accuracy of ±0.5 °F placed on opposite sides of the refrigerant tube surface—resulting in a total of up to 8 temperature measurement devices used for the DX Dual Instrumentation method. In this case, the refrigerant tube shall be insulated with 1-inch thick insulation from a point 6 inches upstream of the measurement location to a point 6 inches downstream of the measurement location. Also, to comply with this requirement, the unit cooler/evaporator entering measurement location may be moved to a location 6 inches upstream of the expansion device and, when testing a condensing unit alone, the entering and leaving measurement locations may be moved to locations 6 inches from the respective service valves.

4.8.2.2 Mass Flow Meter Location.

When using the DX Dual Instrumentation test method of AHRI 1250–2020, applicable for unit coolers, dedicated condensing units, and matched pairs, the second mass flow meter may be installed in the suction line as shown in Figure C1 of AHRI 1250–2020.

4.8.2.3 Subcooling at Refrigerant Mass Flow Meter.

In Section C3.4.5 of Appendix C of AHRI 1250–2020, when verifying sub-cooling at the mass flow meters, only the sight glass and a temperature sensor located on the tube surface under the insulation are required. Subcooling shall be verified to be within the 3 °F requirement downstream of flow meters located in the same chamber as a condensing unit under test and upstream of flow meters located in the same chamber as a unit cooler under test, rather than always downstream as indicated in AHRI 1250–2009, Section C3.4.5. If the subcooling is less than 3 °F when testing a unit cooler, dedicated condensing unit, or matched pair (not a single-packaged system), cool the line between the condensing unit outlet and this location to achieve the required subcooling. When providing such cooling while testing a matched pair, also measure the refrigerant temperature upstream of the location that the line is being cooled, and increase the temperature used to calculate unit cooler entering enthalpy by the difference between the upstream and downstream temperatures.

4.8.2.4 Installation Instructions.

Manufacturer installation instructions or installation instructions described in this section refer to the instructions that come packaged with or appear on the labels applied to the unit. This does not include online manuals.

Installation Instruction Hierarchy: If a given installation instruction provided on the label(s) applied to the unit conflicts with the installation instructions that are shipped with the unit, the label takes precedence. For testing of matched pairs, the installation instructions for the dedicated condensing unit shall take precedence. Setup shall be in accordance with the field installation instructions (laboratory installation instructions shall not be used). Achieving test conditions shall always take precedence over installation instructions.

4.8.2.5 Refrigerant Charging and Adjustment of Superheat and Subcooling.

All test samples shall be charged, and superheat and/or subcooling shall be set, at Refrigeration A test conditions unless otherwise specified in the installation instructions. If the installation instructions give a specified range for superheat, sub-cooling, or refrigerant pressure, the average of the range shall be used as the refrigerant charging parameter target and the test condition tolerance shall be ±50 percent of the range. Perform charging of near-azeotropic and zeotropic refrigerants only with refrigerant in the liquid state. Once the correct refrigerant charge is determined, all tests shall run until completion without further modification.

4.8.2.5.1. When charging or adjusting superheat/subcooling, use all pertinent instructions contained in the installation instructions to achieve charging parameters within the tolerances. However, in the event of conflicting charging information between installation instructions, follow the installation instruction hierarchy listed in section 4.8.2.4. Conflicting information is defined as multiple conditions given for charge adjustment where all conditions specified cannot be met. In the event of conflicting information within the same set of charging instructions (*e.g.,* the installation instructions shipped with the dedicated condensing unit), follow the hierarchy in Table 19 of this appendix for priority. Unless the installation instructions specify a different charging tolerance, the tolerances identified in Table 19 shall be used.

TABLE 19—TEST CONDITION TOLERANCES AND HIERARCHY FOR REFRIGERANT CHARGING AND SETTING OF REFRIGERANT CONDITIONS

Priority	Fixed orifice		Expansion valve	
	Parameter with installation instruction target	Tolerance	Parameter with installation instruction target	Tolerance
1	Super-heat	±2.0 °F	Sub-cooling	10% of the Target Value; No less than ±0.5 °F, No more than ±2.0 °F.
2	High Side Pressure or Saturation Temperature.	±4.0 psi or ±1.0 °F	High Side Pressure or Saturation Temperature.	±4.0 psi or ±1.0 °F.
3	Low Side Pressure or Saturation Temperature.	±2.0 psi or ±0.8 °F	Super-heat	±2.0 °F.
4	Low Side Temperature	±2.0 °F	Low Side Pressure or Saturation Temperature.	±2.0 psi or ±0.8 °F.
5	High Side Temperature	±2.0 °F	Approach Temperature	±1.0 °F.
6	Charge Weight	±2.0 oz	Charge Weight	0.5% or 1.0 oz, whichever is greater.

4.8.2.5.2. *Dedicated Condensing Unit.*

If the Dedicated Condensing Unit includes a receiver and the subcooling target leaving the condensing unit provided in installation instructions cannot be met without fully filling the receiver, the subcooling target shall be ignored. Likewise, if the Dedicated Condensing unit does not include a receiver and the subcooling target leaving the condensing unit cannot be met without the unit cycling off on high pressure, the subcooling target can be ignored. Also, if no instructions for charging or for setting subcooling leaving the condensing unit are provided in the installation instructions, the refrigeration system shall be set up with a charge quantity and/or exit subcooling such that the unit operates during testing without shutdown (*e.g.,* on a high-pressure switch) and operation of the unit is otherwise consistent with the requirements of the test procedure of this appendix and the installation instructions.

4.8.2.5.3. *Unit Cooler.* Use the shipped expansion device for testing. Otherwise, use the expansion device specified in the installation instructions. If the installation instructions specify multiple options for the expansion device, any specified expansion device may be used. The supplied expansion device shall be adjusted until either the superheat target is met, or the device reaches the end of its adjustable range. In the event the device reaches the end of its adjustable range and the super heat target is not met, test with the adjustment at the end of its range providing the closest match to the superheat target, and the test condition tolerance for super heat target shall be ignored. The measured superheat is not subject to a test operating tolerance. However, if the evaporator exit condition is used to determine capacity using the DX dual-instrumentation method or the refrigerant enthalpy method, individual superheat value measurements may not be equal to or less than zero. If this occurs, or if the operating tolerances of measurements affected by expansion device fluctuation are exceeded, the expansion device shall be replaced, operated at an average superheat value higher than the target, or both, in order to avoid individual superheat value measurements less than zero and/or to meet the required operating tolerances.

4.8.2.5.4. *Single-Packaged Unit.* Unless otherwise directed by the installation instructions, install one or more refrigerant line pressure gauges during the setup of the unit, located depending on the parameters used to verify or set charge, as described in this section:

4.8.2.5.4.1. Install a pressure gauge in the liquid line if charging is on the basis of subcooling, or high side pressure or corresponding saturation or dew point temperature.

4.8.2.5.4.2. Install a pressure gauge in the suction line if charging is on the basis of superheat, or low side pressure or corresponding saturation or dew point temperature. Install this gauge as close to the evaporator as allowable by the installation instructions and the physical constraints of the unit. Use methods for installing pressure gauge(s) at the required location(s) as indicated in the installation instructions if specified.

4.8.2.5.4.3. If the installation instructions indicate that refrigerant line pressure gauges should not be installed and the unit fails to operate due to high pressure or low pressure compressor cut off, then a charging port shall be installed, and the unit shall be evacuated of refrigerant and charged to the nameplate charge.

4.8.2.6 Ducted Units.

For systems with ducted evaporator air, or that can be installed with or without ducted evaporator air: Connect ductwork on both the inlet and outlet connections and determine external static pressure (ESP) as described in Sections 6.4 and 6.5 of ANSI/ASHRAE 37. Use pressure measurement instrumentation as described in Section 5.3.2 of ANSI/ASHRAE 37. Test at the fan speed specified in the installation instructions—if there is more than one fan speed setting and the installation instructions do not specify which speed to use, test at the highest speed. Conduct tests with the ESP equal to 50% of the maximum ESP allowed in the installation instructions, within a tolerance of −0.00/+0.05 inches of water column. If the installation instructions do not provide the maximum ESP, the ESP shall be set for testing such that the air volume rate is ⅔ of the air volume rate measured when the ESP is 0.00 inches of water column within a tolerance of −0.00/+0.05 inches of water column.

If testing using either the indoor or outdoor air enthalpy method to measure the air volume rate, adjust the airflow measurement apparatus fan to set the external static pressure—otherwise, set the external static pressure by symmetrically restricting the outlet of the test duct. In case of conflict, these requirements for setting airflow take precedence over airflow values specified in manufacturer installation instructions or product literature.

4.8.2.7 Two-Speed or Multiple-Speed Evaporator Fans. Two-Speed or Multiple-Speed evaporator fans shall be considered to meet the qualifying control requirements of Section C4.2 of Appendix C of AHRI 1250–2020 for measuring off-cycle fan energy if they use a fan speed no less than 50% of the speed used in the maximum capacity tests.

4.8.2.8 Defrost.

Use Section C10.2.1 of Appendix C of AHRI 1250–2020 for defrost testing. The Test Room Conditioning Equipment requirement of Section C10.2.1.1 of Appendix C of AHRI 1250–2020 does not apply.

4.8.2.8.1 Adaptive Defrost.

When testing to certify compliance to the energy conservation standards, use N_{DF} = 4, as instructed in Section C10.2.1.7 or C10.2.2.1 of AHRI 1250–2020. When determining the represented value of the calculated benefit for the inclusion of adaptive defrost, use N_{DF} = 2.5, as instructed in Section C10.2.1.7 or C10.2.2.1 of AHRI 1250–2020.

4.8.2.8.2 Hot Gas Defrost.

When testing to certify compliance to the energy conservation standards, remove the hot gas defrost mechanical components and disconnect all such components from electrical power. Test the units as if they are electric defrost units, but do not conduct the defrost tests described in Section C10.2.1 of AHRI 1250–2020. Use the defrost heat and power consumption values as described in Section C10.2.2 of AHRI 1250–2020 for the AWEF calculations.

When determining the represented value of the calculated benefit for the inclusion of hot gas defrost, test with hot gas mechanical components installed, but do not conduct the defrost tests. Use the defrost heat and power consumption values as described in Section C10.1.1 of AHRI 1250–2020 for the AWEF calculations.

4.8.2.9 Dedicated condensing units that are not matched for testing and are not single-packaged dedicated systems.

The temperature measurement requirements of sections C3.1.3 and C4.1.3.1 Appendix C of AHRI 1250–2020 shall apply only to the condensing unit exit rather than to the unit cooler inlet and outlet, and they shall be applied for two measurements when using the DX Dual Instrumentation test method.

4.8.2.10 Single-packaged dedicated systems.

Use the test method in section C9 of Appendix C of AHRI 1250–2020 as the method of test for single-packaged dedicated systems, with modifications as described in this section. Use two test methods listed in Table 20 of this appendix to calculate the net capacity and power consumption. The test method listed with a lower ''Hierarchy Number'' and that has ''Primary'' as an allowable use in Table 20 shall be considered the primary measurement and used as the net capacity.

TABLE 20—SINGLE-PACKAGED METHODS OF TEST AND HIERARCHY

Hierarchy No.	Method of test	Allowable use
1	Balanced Ambient Indoor Calorimeter	Primary.
2	Indoor Air Enthalpy	Primary or Secondary.
3	Indoor Room Calorimeter	Primary or Secondary.
4	Balanced Ambient Outdoor Calorimeter	Secondary.
5	Outdoor Air Enthalpy	Secondary.
6	Outdoor Room Calorimeter	Secondary.
7	Single-Packaged Refrigerant Enthalpy[1]	Secondary.
8	Compressor Calibration	Secondary.

Notes:

[1] See description of the single-packaged refrigerant enthalpy method in section 4.8.2.10.1 of this appendix.

4.8.2.10.1 Single-Packaged Refrigerant Enthalpy Method.

The single-packaged refrigerant enthalpy method shall follow the test procedure of the DX Calibrated Box method in AHRI 1250–2020, Appendix C, section C8 for refrigerant-side measurements with the following modifications.

4.8.2.10.1.1 Air-side measurements shall follow the requirements of the primary single-packaged method listed in Table 20 of this appendix. The air-side measurements and refrigerant-side measurements shall be collected over the same intervals.

4.8.2.10.1.2 A preliminary test at Test Rating Condition A is required using the primary method prior to any modification necessary to install the refrigerant-side measuring instruments. Install surface mount temperature sensors on the evaporator and condenser coils at locations not affected by liquid subcooling or vapor superheat (*i.e.*, near the midpoint of the coil at a return bend), entering and leaving the compressor, and entering the expansion device. These temperature sensors shall be included in the regularly recorded data.

4.8.2.10.1.3 After the preliminary test is completed, the refrigerant shall be removed from the equipment and the refrigerant-side measuring instruments shall be installed. The equipment shall then be evacuated and recharged with refrigerant. Once the equipment is operating at Test Condition A, the refrigerant charge shall be adjusted until, as compared to the average values from the preliminary test, the following conditions are achieved:

(1) Each on-coil temperature sensor indicates a reading that is within ±1.0 °F of the measurement in the initial test,

(2) The temperatures of the refrigerant entering and leaving the compressor are within ±4 °F, and

(3) The refrigerant temperature entering the expansion device is within ±1 °F. Once these conditions have been achieved over an interval of at least ten minutes, refrigerant

charging equipment shall be removed and the official tests shall be conducted.

4.8.2.10.1.4 The lengths of liquid line to be added shall be 5 feet maximum, not including the requisite flow meter. This maximum length applies to each circuit separately.

4.8.2.10.1.5 Use section C9.2 of Appendix C of AHRI 1250–2020 for allowable refrigeration capacity heat balance. Calculate the single-packaged refrigerant enthalpy (secondary) method test net capacity $\dot{Q}_{net,secondary}$ as follows:

$$\dot{Q}_{net,secondary} = \dot{Q}_{ref} - 3.412.\dot{E}F_{comp,on} - \dot{Q}_{sploss}$$

Where:

$\dot{Q}_{ref}$ is the gross capacity;
$\dot{E}F_{comp,on}$ is the evaporator compartment on-cycle power, including evaporator fan power; and
$\dot{Q}_{sploss}$ is a duct loss calculation applied to the evaporator compartment of the single-packaged systems, which is calculated as indicated below.

$$\dot{Q}_{sploss} = UA_{cond} \times (T_{evapside} - T_{condside}) + UA_{amb} \times (T_{evapside} - T_{amb})$$

Where:

UA_{cond} and UA_{amb} are, for the condenser/evaporator partition and the evaporator compartment walls exposed to ambient air, respectively, the product of the overall heat transfer coefficient and surface area of the unit as manufactured, *i.e.*, without external insulation that might have been added during the test. The areas shall be calculated based on measurements, and the thermal resistance values shall be based on insulation thickness and insulation material;
$T_{evapside}$ is the air temperature in the evaporator compartment—the measured evaporator air inlet temperature may be used;
$T_{condside}$ is the air temperature in the condenser compartment—the measured chamber ambient temperature may be used, or a measurement may be made using a temperature sensor placed inside the condenser box at least 6 inches distant from any part of the refrigeration system; and
T_{amb} is the air temperature outside the single-packaged system.

4.8.2.10.1.6 For multi-circuit single-packaged systems utilizing the single-packaged refrigerant enthalpy method, apply the test method separately for each circuit and sum the separately-calculated refrigerant-side gross refrigeration capacities.

4.8.2.10.2 Detachable single-packaged systems shall be tested as single-packaged dedicated refrigeration systems.

4.8.2.11 Variable-Capacity and Multiple-Capacity Dedicated Condensing Refrigeration Systems.

4.8.2.11.1 Manufacturer-Provided Equipment Overrides.

Where needed, the manufacturer must provide a means for overriding the controls of the test unit so that the compressor(s) operates at the specified speed or capacity and the indoor blower operates at the speed consistent with the compressor operating level as would occur without override.

4.8.2.11.2 Compressor Operating Levels.

For variable-capacity and multiple-capacity compressor systems, the minimum capacity for testing shall be the minimum capacity that the system control would operate the compressor in normal operation. Likewise, the maximum capacity for testing shall be the maximum capacity that the system control would operate the compressor in normal operation. For variable-speed compressor systems, the intermediate speed for testing shall be the average of the minimum and maximum speeds. For digital compressor systems, the intermediate duty cycle shall be the average of the minimum and maximum duty cycles. For multiple-capacity compressor systems with three capacity levels, the intermediate operating level for testing shall be the middle capacity level. For multiple-capacity compressor systems with more than three capacity levels, the intermediate operating level for testing shall be the level whose displacement ratio is closest to the average of the maximum and minimum displacement ratios.

4.8.2.11.3 Refrigeration Systems with Digital Compressor(s).

Use the test methods described in section 4.8.2.10.1 of this appendix as the secondary method of test for refrigeration systems with digital compressor(s) with modifications as described in this section. The Test Operating tolerance for refrigerant mass flow rate and suction pressure in Table 2 of AHRI 1250–2020 shall be ignored. Temperature and pressure measurements used to calculate $\dot{Q}_{ref}$ shall be recorded at a frequency of once per second or faster and based on average values measured over the 30-minute test period.

4.8.2.11.3.1 For Matched pair (not including single-packaged systems) and Dedicated Condensing Unit refrigeration systems, the preliminary test in sections 4.8.2.10.1.2 and 4.8.2.10.1.3 of this appendix is not required. The liquid line and suction line shall be 25 feet ± 3 inches, not including the requisite flow meters. Also, the term $\dot{Q}_{sploss}$ in the equation to calculate net capacity shall be set equal to zero.

4.8.2.11.3.2 For Dedicated Condensing Unit refrigeration systems, the primary capacity measurement method shall be balanced ambient outdoor calorimeter, outdoor air enthalpy, or outdoor room calorimeter.

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